

Division of Aquatic and Wildlife Resources

Guam Department of Agriculture



Annual Report Fiscal Year 1994

Guam
Aquatic
and
Wildlife
Resources
Annual
Report
FY'94

ANNUAL REPORT FISCAL YEAR 1994

DIVISION OF AQUATIC & WILDLIFE RESOURCES

Rufo J. Lujan, Chief

GUAM DEPARTMENT OF AGRICULTURE

Jose A. E. Manibusan, Director

Edited by:

Robert D. Anderson

Gerald W. Davis

Lillian L. Mariano

Todd J. Pitlik

Gary J. Wiles

PERIOD COVERED:

October 1, 1993 to September 30, 1994

Guam
Aquatic
and
Wildlife
Resources
Annual
Report
FY 1994

ACKNOWLEDGEMENTS

The Division of Aquatic and Wildlife Resources, Department of Agriculture, wishes to acknowledge the following persons and organizations for their assistance in our work:

Members of the Guam Fishing & Boating Association, the Marianas Fishing Derby Committee and the Manager of the Guam Fishermens's Coop for allowing fishery biologists to examine their fish;

Fishermen who have cooperated with fishery data collection;

Individuals who have reported poaching activities and bird sightings;

Hunters who have cooperated with wildlife data collection by filling out and returning hunter questionnaires;

Base Commanders of the U.S. Naval Magazine, Naval Station, Naval Computer and Telecommunications Master Station, and Andersen Air Force Base;

Security Officers and their staffs at the U.S. Naval Magazine, Naval Computer and Telecommunications Master Station, and Andersen Air Force Base;

Staff and management of KGTF Channel 12;

Print and electronic media for coverage of our programs and activities and for their support of conservation education programs;

Personnel of the Naval Oceanographic Command Detachment, U.S. Naval Air Station, Guam, for providing weather data;

The Marine Lab, University of Guam;

Personnel from the Office of Enforcement, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, U.S. Department of Commerce;

Personnel from the Division of Law Enforcement, U.S. Fish and Wildlife Service, U.S. Department of the Interior.

TABLE OF CONTENTS

FY 1994

	Page
Section I Coordination and Administration – Project FW-3C-2 (Federal Aid in Sport Fish and Wildlife Restoration Acts)	
Job C-1-1 Coordination of Guam's Fish and Wildlife Programs	1
Section II Guam Fisheries Investigations – Project F-1R-2 (Federal Aid in Sport Fish Restoration Act)	
Job F-1-1-1 Offshore Fisheries Survey	6
Guam International Fishing Derby (Appendix 1)	15
Job F-1-1-2 Inshore Fisheries Survey	20
Inshore Aerial Survey (Appendix 1)	30
Job F-1-2-1 Fisheries Data Processing	33
Job F-1-3-1 Biology of <i>Lethrinus harak</i> and <i>L. obsoletus</i>	35
Job F-2-1-2 Development of Recreational Fishing in Fena Lake	41
Job F-3-1 Technical Guidance to Projects Affecting Guam's Fish Resources	42
Section III Guam Fisheries Development – Project F-2-D (Federal Aid in Sport Fish Restoration Act)	
Job F-2-D-6 Marine Fish Habitat Improvement and Aggregating Devices	45
Job F-2-D-7 Development of Boat Launching Facilities	54
Job F-2-D-9 Development of Inshore Fishing Access Facilities	56
Job F-2-D-10 Restoration of Masso Reservoir	58
Non-Federally Funded Projects	
Commercial Fisheries	59

		Page
Section IV	Guam Wildlife Investigation Project W-1R-2 (Federal Aid in Wildlife Restoration Act)	
Job W-1-1-1	Determination of Current Population Size and Distribution of Guam Deer	61
	The Population Size and Distribution of Wild Asiatic Water Buffalo on Guam (Appendix 1)	66
Job W-1-2-1	Population Size and Distribution of Wild Pigs on Guam	68
Job W-2-1-1	Population Numbers and Distribution of Philippine Turtle Doves	71
Job W-2-2-1	Population Size and Distribution of Black Francolin on Guam	75
Job W-4-1-1	Survey and Inventory of Non-Game Birds	79
Job W-5-1-1	Natural History, Biology, and Habitat Protection for Marianas Fruit Bats	90
Job W-5-1-2	Roost Site Characteristics of Marianas Fruit Bats	98
Job W-6-1	Technical Guidance to Projects Affecting Guam's Wildlife Resources	99
Section V	Guam Endangered Species Investigation Project E-1-9 (Section 6 – Endangered Species Act of 1973)	
Job 4-1	Captive Breeding Endangered Native Birds Analysis of the 1993 North American Regional Studbook of the Micronesian Kingfisher <i>Halcyon cinnamomina cinnamomina</i> (Appendix I)	104 109
Job 4-2	Development of an Experimental Population of Guam Rails in the Commonwealth of the Northern Mariana Islands An Assessment of Potential Predators in the Release Area of the Guam Rail Introduction Program, Rota, CNMI (Appendix I)	111 115
Job 7-3	Development and Testing of Control Methods for the Brown Tree Snake	122

JOB PROGRESS REPORT COORDINATION PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: FW-3C-2

SUB-PROJECT NO.: C-1

JOB NO.: 1

JOB TITLE: Coordination of Guam's Fish and Wildlife Programs (1630, 2630)

PERIOD COVERED: October 1, 1993 to September 30, 1994

OBJECTIVES

To plan, coordinate, supervise, and administer all fish and wildlife restoration and endangered species programs.

PROCEDURES

1. Supervise the planning and documentation of the Fish and Wildlife programs.
2. Administer all fiscal and budgetary matters and coordinate with the Central Accounting and Budget Office.
3. Administer all personnel matters including recruitment of off-island staff.
4. Represent the Division and Department of Agriculture in all matters pertaining to Fish and Wildlife Resources.

RESULTS

The Division experienced several staff changes during the year, and has suffered a net loss of staff:

Administration: Arlean Perez-Kloppenbergh joined the staff as a Management Analyst III and is assigned to assist Public Information Officer Lillian Mariano with the Division's Public Awareness and Conservation Education (PACE) program. Judith Diaz joined the staff as a Secretary I (Typist).

Wildlife: Biologist III (Aviculture) M. Kelly Brock joined the staff in October and assigned to the Guam rail captive breeding and Rota relocation projects. Biologist I Mike Ritter resigned to accept a position as a wetland biologist with the U.S. Fish and Wildlife Service in Honolulu, Hawaii. Wildlife Technician I Kara Wells resigned to get married and to relocate with her husband to the mainland.

Fisheries: Fishery Biologist III Todd Pitlik and Technician J. P. Gesner joined the staff.

Law Enforcement: Conservation Officer I Herbert Anderson resigned during the reporting period. At the end of the reporting period there were four positions for Conservation Officer I vacant.

At the end of the reporting period the Division had the following vacant positions:

- Biologist III (Game Management)
- Wildlife Biologist III (Wetlands)
- Wildlife Biologist III (Brown Tree Snake)
- Wildlife Biologist II (Brown Tree Snake)
- Wildlife Biologist II
- Wildlife Biologist I
- Fisheries Biologist II (Non-fish)--Local funding, position frozen
- Fisheries Biologist II (Freshwater)
- Programmer (Fisheries Data Processing)
- Fisheries Technician I
- Wildlife Technician II
- Wildlife Technician I (Brown Tree Snake)
- Wildlife Technician I
- Conservation Officer I
- Conservation Officer I--Local funding, position frozen
- Conservation Officer I--Local funding, position frozen
- Conservation Officer I--Local funding, position frozen

Filling of the above positions is dependent upon the availability of the necessary funding, particularly in the case of the vacant positions within the Wildlife Section, which is totally dependent upon Pittman-Robertson and Section 6 Endangered Species Act funds.

Division staff spent the first quarter preparing the annual Job Progress Reports on the research and other activities conducted during FY93 under its various federal programs and submitted them to the U.S. Fish and Wildlife Service Regional Office.

Staff also devoted considerable effort to preparing the Federal Aid project documentation necessary to obligate funds for the Division's various programs during FY94. This documentation included new five-year Grant Proposals and annual Grant Agreements for 1) Project FW-3C, Guam Fish and Wildlife Coordination, which covers the administration and coordination of the Division's Federal Aid programs and which is jointly funded by wildlife (PR) and sport fisheries (DJ) funds; 2) Project F-1R, Guam Sport Fish Investigations, which covers sport fish research and survey activity and which is funded with sport fisheries (DJ) funding; and 3) Project W-1R, Guam Wildlife Investigations, which covers wildlife research and survey activity and which is funded with wildlife (PR) funds. In addition, annual Grant Agreements and Amendments were prepared for the Division's various Fisheries Development and Endangered Species Investigations projects.

Considerable effort was also invested into preparing funding proposals for the National Wetlands Conservation Grant Program, Legacy Fund proposals to the Air Force and Navy for assistance with our various endangered species recovery programs, and the Fish and Wildlife Service in Honolulu for similar endangered species support.

The Division Chief and his staff represented the Division and the Department of Agriculture in all matters relating to fish and wildlife resources. This frequently entailed meetings with other agencies of the Government of Guam, various Federal agencies, and the military. The Division's administration and coordination responsibilities are 50% funded by local funds.

The Chief served on the Department's Land Lease Approving Committee, which must review and approve all proposed leases of government land for agricultural purposes. He also serves as a member of the Territorial Land Use Commission. In addition, the Chief also serves as the Government of Guam's representative to the Western Pacific Regional

Fisheries Management Council. The Chief is also a member of the Area Committee for Oil Spill Response.

The Assistant Chief continued to serve as a member of the Technical Advisory Committee for the I Tano'ta land use plan being developed by the Territorial Planning Council. He also served as a member of the Technical Review Committee for the Andersen Air Force Base Institution Restoration Program (IRP) as well as for various Navy IRP's. In addition, he served as Vice Chairman of the Criminal Justice Advisory Committee at Guam Community College.

The Assistant Chief supervised the locally-funded Technical Assistance Program, staffed by Biologist I Marvin Aguilar and Biologist I Georgette Concepcion.

The Assistant Chief and Fisheries Supervisor both served on the Oiled Wildlife Subcommittee of the Area Committee for Oil Spill Response.

Biologist III Celestino Aguon and Biologist III Gary Wiles were appointed to the Pacific Insular Recovery Team and Biologist III M. Kelly Brock was appointed as a member of the Captive Breeding Working Group, sponsored by the U.S. Fish and Wildlife Service.

Division staff made a number of off-island trips related to Federal Aid programs:

The Assistant Chief attended the 1993 Federal Aid Coordinators Conference held in Newport, Oregon in October 1993.

Biologist I Marvin Aguilar attended a Dredged Material Management Workshop in Honolulu, Hawaii in December 1993. The workshop was sponsored by the Army Corps of Engineers.

Division Chief Rufo J. Lujan represented Guam at the 25th Regional Technical Meeting on Fisheries at the South Pacific Commission headquarters in Noumea, New Caledonia. Travel was funded by the South Pacific Commission.

Fisheries Supervisor Gerald W. Davis attended the Aquatic Resources Education Conference in Pennsylvania in July 1994.

Division Chief Rufo J. Lujan traveled to Maui, Hawaii in January 1994 to attend the annual meeting of the Western Section of the Wildlife Society. The theme of the conference was Ecosystem Management.

Division Chief Rufo J. Lujan attended the Twenty Fourth Forum Fisheries Meeting in Honiara, Solomon Islands in April 1994.

Biologist III Andrew Torres attended the Bottomfish Plan Monitoring Team meeting in Honolulu, Hawaii in June 1994, funded by the Western Pacific Regional Fisheries Management Council.

Biologist III Andrew Torres attended a Sea Turtle Workshop sponsored and funded by the South Pacific Regional Environmental Program and held in Western Samoa in July 1994.

Fisheries Biologist Robert F. Myers attended the Pelagic Plan Monitoring Team meeting in Honolulu in June 1994 funded by the Western Pacific Regional Fisheries Management Council.

Division Chief attended the Fisheries Data Coordinating Committee Meeting in Honolulu in April 1994, funded by the Western Pacific Regional Fisheries Management Council.

Division Chief Rufo J. Lujan attended the 80th meeting of the Western Pacific Regional Fisheries Management Council in Honolulu in April 1994.

Division Chief Rufo J. Lujan and Deputy Director Jose Manibusan traveled to Saipan in February 1994 to confer with the new Director of Natural Resources in the CNMI and to discuss cooperative projects.

Division Chief Rufo J. Lujan, accompanied by Deputy Director Jose Manibusan, Wildlife Supervisor Robert Beck, and Biologist III M. Kelly Brock visited Rota in February 1994 to discuss the Rota Rail Introduction Project with the new Mayor, to meet with the CNMI biological staff on Rota, and to visit previous release sites to survey for the possible presence of rails that may remain from previous releases.

Fisheries Technician II Glenn San Nicolas attended a six-month Fisheries Training Course at the Nelson Polytechnic Institute in New Zealand. The course was sponsored and funded by the South Pacific Commission.

Biologist III M. Kelly Brock and Biologist I Josephine Perez visited Rota for a period of one week in June in preparation for the next release of Guam rails. While on Rota they surveyed the rat population in the area of the release site and conducted radio range and bias determinations in preparation for radio telemetry monitoring of released rails.

Biologist III M. Kelly Brock made a follow-up visit to Rota in July, during which she did further rat trapping and further work to establish monitoring stations for radio telemetry of released rails. The timing of this trip was coordinated with a visit of a group of scientists from the Smithsonian Institution and a number of zoos, who were on Rota working on Mariana crows. This allowed consultation between the parties regarding various aspects of the rail, kingfisher, and crow recovery programs.

Administrative Officer Janet Blas traveled to Honolulu, Hawaii in April 1994 to receive training in the USFWS internal accounting system and in Lotus 1-2-3 Accounting Software.

Biologist I Tom Flores participated in an SPC sponsored and funded survey of *Trochus* (topshells) in the Commonwealth of the Northern Mariana Islands in May 1994.

Biologist I Georgette Concepcion attended the Second Coastal Protection Meeting in Suva, Fiji in May, 1994, sponsored and funded by the South Pacific Applied Geoscience Commission (SOPAC) and the South Pacific Regional Environmental Program (SPREP).

Biologist III Celestino Aguon and Biologist III Gary Wiles participated in the first meeting of the Pacific Insular Recovery Team in Hilo, Hawaii in May 1994. In conjunction with this trip they also conferred with the staff of the Hawaiian crow recovery project.

Biologist III M. Kelly Brock attended the Pacific Avifauna Recovery Committees meeting of the Captive Breeding Working Group in Hilo, Hawaii in April 1994. In conjunction with this trip she also visited the Olinda Endangered Species Captive Propagation Facility on Maui and the Big Island Captive Propagation Facility to confer with the staff of the endangered Hawaiian crow (Alala) project.

Conservation Officers Sgt. Michael Reyes, and CO I Eduardo Nieves attended a Motorboat Operators School sponsored by the National Marine Fisheries Service (NMFS) and held at the Federal Law Enforcement Training Center at Glyncro, Georgia. Funding was provided by NMFS.

Division Chief Rufo J. Lujan attended the 28th Annual Conference of the Law of the Sea Institute, University of Hawaii in July 1994. The conference theme was Ocean Governance: Strategies and Approaches for the 21st Century.

Fisheries Supervisor Gerald W. Davis attended the Scientific Statistical Committee meeting of the Western Pacific Regional Fisheries Management Council in Honolulu in August 1994.

Division Chief Rufo J. Lujan attended the 1994 Annual Meeting of the Pacific Basin Development Council in Waikoloa, Hawaii in August 1994. In conjunction with this trip he also visited the Hakalau National Wildlife Refuge.

Division Chief Rufo J. Lujan attended the 84th Annual Meeting of the International Association of Fish and Wildlife Agencies in Bismarck, South Dakota in September 1994.

The Division hosted a number of off-island visitors during the year.

PROGRAM COST

The estimated cost of the project under FW-3C-2 is \$56,500.

Report prepared by: Robert D. Anderson

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-IR-2
SUB-PROJECT NO.: F-1
STUDY NO.: 1
JOB NO.: 1

STUDY 1: Fisheries Participation, Effort, and Harvest Surveys (2430)

JOB 1: Offshore Fisheries Survey

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

Monthly offshore fisheries surveys were conducted at the Agana Boat Basin and other boat launching locations along Guam's shoreline from October 1993 through September 1994. An island-wide finfish catch from small recreational-type vessels was estimated at 415.8 metric tons (MT) for that period. An estimated 313,561 person-hours were spent during 90,511 boat-hours of fishing. The bulk of the catch, 336.7 MT, was landed by trolling during an estimated 70,484 boat-hours of effort. Nearly all of the troll catch, 97.1%, consisted of five major pelagic species. Bottomfishing produced an estimated 43.7 MT, and night-light jigging for atulai produced an estimated 2.9 MT. Spearfishing produced 28.3 MT of finfishes and shellfish. Approximately 4.3 MT of finfish and shellfish were caught by nets. Catches by infrequently encountered methods may be under-estimated as follows: spearfishing (18%); nightlight jigging for atulai (24%); and nets (15%). Deficiencies in the current survey design and analysis have been identified. These will be rectified with the implementation of a new survey design and new computerized data base during FY'95.

BACKGROUND

Effective management of the island's offshore fishery resources requires accumulating data on fishing pressure, types of fishing methods used and annual harvest. In order to identify trends in fishing participation, effort, and catch, the Division of Aquatic and Wildlife Resources (DAWR) has been monitoring offshore fishing activities for the past 15 years. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff. During the early 1980s major advances were made in both field survey techniques and in the area of computerized statistical analysis. The combined efforts of DAWR and National Marine Fisheries Service (NMFS) personnel through the Western Pacific Fisheries Information Network (WPACFIN) program (see Study F-1, Job 3) made it possible to employ computerized statistical analysis for the period FY77-91. However, statistics could not be computed for FY92-94 estimates due to the lack of adequate computer hardware and software.

OBJECTIVES

To establish baseline catch and effort data for reef fish, bottomfish and pelagic species necessary to develop a fisheries management plan for Guam and to gather limited biological data on these fisheries.

PROCEDURES

During FY94, interviews of returning offshore fishing parties were conducted on four days each month at the Agana Boat Basin. Two of these days were randomly selected weekdays and two were randomly selected weekend days (which, in this report, includes holidays). Each survey consisted of two periods, one from 0500 to 1200 hours (previously to only 1100 hours) and the other from 1600 to 2400 hours. In addition, interviews from the southern launching site of Merizo Pier were obtained on one day per month, alternating between weekdays and weekends from the hours of 0600 to 1100 and 1600 to 2000. Island-wide participation was determined by means of a morning and evening survey of all public boat launching areas in which all trailers attached to vehicles were counted, but no interviews were taken. This assumes that the ratio of boat trips participating in fishing to boat trips not participating in fishing as well as the proportion of boats engaging in each method for boats utilizing the Agana Boat Basin is representative of the island as a whole.

Sampling and analytical procedures used remain unchanged from those of the last two years with preliminary estimates without statistical analysis determined through the use of a computerized spreadsheet. The following steps were taken to obtain monthly estimates of total participation, effort, and catch for all methods as well as total number and weight for all trolling species and selected important bottomfish species:

1. Participation, effort, catch, and total number and weight of selected species for each method and returning boat were summed for each survey day.
2. Totals for each survey day were divided by P_1 and P_2 ratios to obtain an island-wide estimate. The method for determining P_1 and P_2 values is outlined in the FY85 annual report.
3. The average of each daily parameter for each type day (weekday [WD] or weekend/holiday [WE/H]) was multiplied by the number of each type day in the month to obtain WD and WE/H monthly estimates. WD and WE/H totals were summed to obtain monthly totals.
4. Estimates for the month of July for trolling and bottomfishing are based on a 28-day expansion, with the catch, effort, and participation during the Guam International Fishing Derby (GIFD) added for trolling and bottomfishing (Appendix 1).
5. Summary estimates for the remaining methods are based on a 31-day expansion for July. Other one and two-day derbies with relatively low turnouts were not considered separately from the normal expansion.
6. The method used to assess the degree of under-sampling is outlined in the FY90 annual report.

RESULTS

Trolling

Including the Guam International Fishing Derby (GIFD; Appendix 1), an estimated 336.6 MT of troll-caught fish were landed island-wide during FY94 (Table 1). An estimated 70,484 boat-hours were spent trolling with an average catch rate of 4.8 kg/boat-hour. Monthly catch rates as catch per unit of effort (CPUE), ranged from 3.3 kg/boat-hour in September to 7.1 kg/boat-hour in May.

Table 1. Estimated monthly trolling participation, effort, and catch during FY94. Estimates include the Guam International Fishing Derby (GIFD). Weights are in kilograms (1 Kg = 2.2046 lbs).

MONTH	Persons	Boat hours	Person hours	Kilograms	Kg/ per- son	Kg/ boat- hour	Kg/ person- hour
OCT	5,681	6,781	22,827	25,811	4.5	3.8	1.1
NOV	5,703	5,021	19,657	24,597	4.3	4.9	1.3
DEC	4,705	6,475	17,794	34,152	7.3	5.3	1.9
JAN	5,227	5,097	19,980	26,627	5.1	5.2	1.3
FEB	7,251	7,208	27,914	29,942	4.1	4.2	1.1
MAR	4,713	4,465	16,697	24,693	5.2	5.5	1.5
APR	5,511	6,833	24,498	34,147	6.2	5.0	1.4
MAY	5,754	6,101	22,098	43,444	7.5	7.1	2.0
JUN	7,189	7,789	36,458	34,333	4.8	4.4	0.9
JUL	6,100	7,621	26,975	34,514	5.7	4.5	1.3
AUG	3,805	3,778	12,740	13,516	3.6	3.6	1.1
SEP	3,605	3,316	12,124	10,871	3.0	3.3	0.9
FY94	65,243	70,484	259,761	336,646	5.2	4.8	1.3

The usual five pelagic species accounted for the bulk of the catch (97.1%; Table 2). However, the composition differed greatly from that of last year. Skipjack tuna (*Katsuwonus pelamis*) and mahimahi (*Coryphaena hippurus*) each accounted for slightly more than a quarter of the landings (27.8% and 26.8%, respectively) followed by blue marlin (*Makaira nigricans*; 19.7%), wahoo (*Acanthocybium solandri*; 14.1%), and yellowfin tuna (*Thunnus albacares*; 8.6%).

Table 2. Monthly composition of the Guam trolling catch during FY94. Estimates include the Guam International Fishing Derby (GIFD). Weights are in kilograms (1 Kg = 2.2046 lbs).

MONTH	Mahimahi	Wahoo	Skipjack tuna	Yellowfin tuna	Blue marlin	Other
OCT	4,811	2,726	6,082	538	10,753	911
NOV	4,056	14,956	1,263	1,976	1,629	717
DEC	15,614	10,761	2,639	2,417	1,743	978
JAN	14,355	1,906	4,590	3,751	497	1,525
FEB	15,085	2,105	6,976	5,315	0	460
MAR	15,667	2,432	5,081	1,214	0	300
APR	11,561	3,277	17,404	1,618	0	287
MAY	8,762	2,273	18,453	3,298	8,438	2,220
JUN	155	1,045	9,984	3,002	19,545	602
JUL	39	1,424	12,039	2,950	17,028	1,033
AUG	99	2,218	4,847	2,331	3,494	526
SEP	161	2,451	4,331	461	3,249	217
FY94	90,366	47,573	93,689	28,872	66,377	9,766

The estimated troll fisheries catch for FY94 was 8.5% smaller than the preceding year's record catch. Landings of mahimahi (90.4 MT) were down 49.7% from the extended run of last year and landings of yellowfin tuna (28.9 MT) were down by 23.9%. However, landings of the remaining major species made up for most of the shortfall with skipjack

tuna (93.7 MT) up by 36.7%, wahoo (47.6 MT) up by 33.0%, and blue marlin (66.4 MT) up by 107.4%.

The estimated number of boat hours spent fishing (70,484), and person hours spent fishing (259,761) were slightly higher than those of last year. This resulted in an overall catch rate of 4.8 kg/boat hour, approximately 19% lower than that of the preceding year. The doubling of the blue marlin catch to a record level slightly higher than those of FY90-92 was probably due to a rebound in charter fishing which tends to operate larger boats and target larger fishes. However, without a separate analysis of the charter boat segment of the fishery, it is impossible to determine the impact of charter activity with any degree of confidence.

Bottomfishing

An estimated 43.7 MT of bottomfishes were landed island-wide during FY94 (Table 3). Estimated monthly catches ranged from a high of 10.6 MT in October to a low of 243 kg in December. Bottomfish landings fluctuated widely, with catches of less than 1 MT occurring in December, January, and March. An estimated 39,242 person-hours were spent during 15,152 boat-hours of bottomfishing, resulting in an overall catch rate of 2.9 kg/boat-hour. Monthly catch rates ranged from 1.0 kg/boat-hour in December to 5.2 kg/boat-hour in June.

Table 3. Estimated monthly bottomfishing participation, effort, and catch during FY94. Weights are in kilograms (1 Kg = 2.2046 lbs).

MONTH	Persons	Boat hours	Person hours	Kilograms	Kg/ per- son	Kg/ boat- hour	Kg/ person- hour
OCT	1,433	3,202	7,403	10,636	7.4	3.3	1.4
NOV	1,113	1,504	4,422	1,934	1.7	1.3	0.4
DEC	182	245	490	243	1.3	1.0	0.5
JAN	347	399	1,075	665	1.9	1.7	0.6
FEB	833	1,023	3,086	1,903	2.3	1.9	0.6
MAR	167	318	762	483	2.9	1.5	0.6
APR	780	1,063	3,157	3,014	3.9	2.8	1.0
MAY	748	1,054	2,846	3,932	5.3	3.7	1.4
JUN	969	1,328	3,874	6,883	7.1	5.2	1.8
JUL	1,130	1,957	5,160	7,605	6.7	3.9	1.5
AUG	1,220	1,755	3,582	3,697	3.0	2.1	1.0
SEP	771	1,305	3,384	2,663	3.5	2.0	0.8
FY94	9,694	15,152	39,242	43,659	4.5	2.9	1.1

Estimated bottomfishing participation, effort, and catch for FY94 were the highest since FY85. The increase in catch of 72% above that of FY93 exceeded increases in participation (13% for person-trips) and effort (20% for boat-hours spent bottomfishing), resulting in the highest catch rate since FY85.

The composition of the FY94 catch was nearly evenly divided between shallow and deep water species (Table 4). The single most important species was the onaga with 5.1 MT landed, followed by the redgill emperor with 3.3 MT landed. Deepwater snappers accounted for 41% of the total landings and 81% of the deepwater fraction.

Table 4. Estimated composition of the bottomfishing catch during FY94. Weights are in kilograms (1 Kg = 2.2046 lbs). The unidentified portions of the shallow and deep catches are proportionately partitioned among their identified portions. The term "shallow" refers to depths of less than 150 m and the term "deep" refers to depths below 150 m.

TAXA	Weight landed	% of Total catch	% of Shallow portion	% of Deep portion
Sharks	1,181.6	2.6	5.5	
Serranidae (Groupers)				
<i>Cephalopholis sonnerati</i> (Tomato grouper)	254.3	0.6	1.2	
<i>Epinephelus fasciatus</i> (Black-tipped grouper)	1,322.1	2.9	6.1	
<i>E. octofasciatus</i> (Eightbar grouper)	1,055.5	2.5		4.8
<i>Variola louti</i> (Lyretail grouper)	534.0	1.2	2.5	
Carangidae (Trevallys)				
<i>Caranx lugubris</i> (Black trevally)	1,474.3	3.2	6.8	
<i>Elagatis bipinnulatus</i> (Rainbow runner)	366.5	0.8	1.7	
<i>Seriola dumerili</i> (Amberjack)	742.0	1.8		3.4
Lutjanidae (Snappers)				
<i>Aphareus rutilans</i> (Lehi)	2,722.8	6.5		12.4
<i>Aprion virescens</i> (Jobfish)	1,210.7	2.7	5.6	
<i>Etelis carbunculus</i> (Ehu)	1,488.1	3.6		6.8
<i>E. coruscans</i> (Onaga)	5,118.0	12.2		23.3
<i>Lutjanus kasmira</i> (Blueline snapper)	768.6	1.7	3.5	
<i>Pristipomoides argyrogrammicus</i> (Blueline gindai)	415.4	1.0		1.9
<i>P. auricilla</i> (Yellowtail kalikali)	3,020.6	7.2		13.8
<i>P. filamentosus</i> (Pink opakapaka)	625.5	1.5		2.9
<i>P. flavipinnis</i> (Yellow-eye opakapaka)	1,598.8	3.8		7.3
<i>P. seiboldi</i> (Seibold's snapper)	266.0	0.6		1.2
<i>P. zonatus</i> (Gindai)	2,435.6	5.8		11.1
Lethrinidae (Emperors)				
<i>Lethrinus amboinensis</i> (Ambon emperor)	454.5	1.0	2.1	
<i>L. rubrioperculatus</i> (Redgill emperor)	3,324.6	7.3	15.3	
Sphyraenidae (Barracudas)				
<i>Sphyraena barracuda</i> (Great barracuda)	940.6	2.1	4.3	
<i>S. qenie</i> (Chevron barracuda)	774.7	1.7	3.6	
Scombridae (Tunas)				
<i>Gymnosarda unicolor</i> (Dogtooth tuna)	642.0	1.4	3.0	
Other deepwater species	2,485.6	5.9		11.3
Other shallow water species	8,535.5	18.8	39.3	
Total Shallow	21,686.0	49.7	100.4	
Total Deep	21,973.2	50.3		100.0
Total	43,659.2	100.3	100.4	100.0

The most important deepwater species after onaga were the other snappers yellowtail kalikali (3.0 MT), lehi (2.7 MT), gindai (2.4 MT), yellow-eye opakapaka (1.6 MT), and ehu (1.5 MT) followed by the eightbar grouper (1.1 MT), and amberjack (0.7 MT). The most important shallow water species after the redgill emperor were the black trevally (1.5 MT), black-tipped grouper (1.3 MT), jobfish (1.2 MT), great barracuda (0.9 MT), and chevron barracuda (0.8 MT). Eighteen percent of the overall landings and 37% of the

shallow water fraction consisted of a large number of species which each comprised less than 1% of this fraction. It should be noted that occasional exceptionally large catches of a given species or even a single large fish could have a large influence on the species composition. This was the case with onaga where a single large catch accounted for 70% of the annual estimated landings.

The species composition for FY94 differs from the long-term situation for FY80-91 in which only a third of the catch consisted of deepwater species. Although it is not possible to partition participation and effort into shallow and deepwater fractions, the combination of good weather and high level of activity of certain "highliners" are the most likely reasons. The 22.0 MT of deepwater bottomfish species approaches the combined annual equilibrium yield of 23.4 MT for the Guam-Galvez-Santa Rosa Banks region. However, the estimated FY94 landings also include catches from Rota Banks, 45° Bank, and Esmerelda Bank in the CNMI. Unfortunately an examination of catch by area is not possible.

Spearfishing

Estimated monthly and annual participation, effort, and catch for spearfishing from boats during FY94 are summarized in Table 5. (Readers should also refer to Study F-1, Job 2 for estimates of spearing from shore, i.e., without the use of boats, to gain a more complete picture of FY94 spearfishing activities on Guam.)

Table 5. Estimated monthly offshore spearfishing (with and without scuba) participation, effort, and catch during FY94. Weights are in kilograms (1 Kg = 2.2046 lbs).

MONTH	Persons	Boat hours	Person hours	Kilograms	Kg/ per- son	Kg/ boat- hour	Kg/ person- hour
OCT	146	56	167	2,226	15.2	40.1	13.4
NOV	686	418	1,084	4,812	7.0	11.5	4.4
DEC	133	41	150	1,037	7.8	25.1	6.9
JAN	155	119	127	93	0.6	0.8	0.7
FEB	239	68	206	1,077	4.5	15.7	5.2
MAR	42	58	116	115	2.7	2.0	1.0
APR	314	146	477	1,624	5.2	11.1	3.4
MAY	290	91	395	1,295	4.5	14.2	3.3
JUN	1,072	673	2,247	6,867	6.4	10.2	3.1
JUL	967	509	2,103	7,222	7.5	14.2	3.4
AUG	123	123	246	462	3.8	3.8	1.9
SEP	352	356	1,106	1,468	4.2	4.1	1.3
FY94	4,519	2,659	8,424	28,297	6.3	10.6	3.4

An estimated record 28.3 MT of speared fish, crustaceans, and mollusks were landed from boats during FY94. This was 37% more than that of the preceding year and considerably higher than catches of most other recent years.

The bulk of the catch (67.8%) was taken by scuba diving although more than twice as much effort in terms of person-hours (5,703 vs. 2,722) was attributed to snorkeling. The overall catch rate for spearfishing in FY94 was 3.4 kg/person hour with the catch rate by scuba diving more than four times that by snorkeling (7.1 vs 1.6 kg/person hour). This is a continuation of the trend of the preceding two years that show decreasing catches by snorkeling and improving catches by scuba diving. Although no confidence limits could be

placed on the FY90-94 estimates, this trend could be an indication of over-harvesting of the shallowest and most accessible resources and is a cause for concern. Composition of the FY94 catch has not been determined, but is expected to reflect the increasing landings of scuba-caught species. It is believed that the expansion method used underestimated the participation, effort, and catch for this method by about 18%.

Atulai Night-Light Jigging

Atulai (*Selar crumenophthalmus*) fishing was encountered during every month except December, January, August, and September. An estimated 2.9 MT of fishes were landed by night-light jigging during 1,415 boat-hours of effort. These figures are 74% and 45% lower than last year's respectively. This is consistent with a pattern of wide fluctuations in catch, effort, and catch rates for this fishery. Although composition has not yet been determined, nearly all of the observed catch consisted of atulai (*Selar crumenophthalmus*). It is believed that the expansion method used underestimated the participation, effort, and catch for this method by about 24%.

Other Methods

Other rarely encountered methods during FY94 included gill-netting and cast-netting. Together, they produced an estimated catch of 4.3 MT of finfishes and shellfish during 799 boat-hours and 1,700 person-hours of effort. It is believed that the expansion method used underestimated the participation, effort, and catch for gill netting and cast netting by about 15%.

RECOMMENDATIONS

There is little doubt that the reliability of estimates of island-wide catch and effort based on the present survey is limited by the quality of participation data taken at sites other than the Agana Boat Basin under the assumption that activity as well as catches landed there are representative of the island as a whole. However, data collected at Merizo Pier during FY89-94 indicates that this is not the case, but that there is proportionately much less trolling activity and much more bottomfishing, spearfishing, and gillnet activity occurring there. We still do not have a clear idea how much boating participation takes place from less accessible landings (e.g. the private Achang Bay Marina), nor do we know the proportionality of the various methods at these areas or at the Agat Marina. Island-wide estimates for the past several years are therefore disproportionately high for trolling, but low for other methods. Since these other methods are the only ones that are locally manageable, it is imperative that the survey results are unbiased as well as based on an adequate sample of interviews from launch sites other than the Agana Boat Basin. Separate expansions for the Agana Boat Basin and other boat launching sites would be desirable. It will also be necessary to reassess annual island-wide estimates of catch and effort as far back as possible.

Since all major trolling species have broadly distributed stocks, some of which are believed to be Pacific-wide, meaningful management and conservation of these resources will only be possible by international regional cooperation. This will require that databases be made available from as many sources and areas as possible, and that any biological assessment be based on adequate region-wide data. There are presently few areas from which adequate data on recreational or subsistence fisheries are available, significant gaps in the data for both foreign and domestic distant-water fisheries, and virtually no information on the interaction of recreational and large-scale commercial fisheries in the western Pacific. It is therefore essential that the current time-series of data from Guam be maintained. Since Guam's recreational troll fishery is incapable of taking more than a fraction of a percent of

these stocks and could not have an adverse affect on them, and since the activities of both domestic and foreign large-scale commercial fisheries can significantly affect the performance of Guam's recreational fishery, it is imperative that Guam's recreational fisheries interests be represented and protected in any regional forum.

The increased activity of fishers targeting deepwater bottomfishes deserves attention since continued growth in this fishery could exceed the MSY.

The recent trend of sharply increased catches for spearfishing while using scuba equipment appears to be a direct result of a small core of commercial spearfishermen concentrating their efforts in waters over 30 m deep, primarily at night. Many of the targeted species are also important in shallower inshore fisheries where they have become depleted. Unlimited spearfishing with the use of scuba, particularly at night, is a potentially serious threat to the wellbeing of many reef fish species and their fisheries. This is particularly true for diurnal herbivores such as parrotfishes, surgeonfishes, and unicornfishes that sleep at night and generally do not occur beyond the range of scuba. Without a working database, it is difficult to monitor the status of reef fish fisheries or to determine the degree of interaction between them.

In order to effectively manage those fisheries that are specific to Guam, or to Guam and nearby islands and banks, additional biological information is needed on major bottom- and spearfished species. The offshore survey is currently too infrequent to obtain sufficient data to perform certain length-based analyses of any of these species. It is recommended that separate studies of the major bottomfish species be implemented that examine reproduction and ecology as well as length-frequency distributions. Comparisons with the inshore survey will have to be made to determine which spearfished species require further study.

Properly located preserves would protect the spawning stock of the most vulnerable reef and bottomfish species.

In order to address the problems described above, the following projects have been implemented or proposed:

1. The offshore fisheries survey is being redesigned and the Guam Offshore Expansion System (GOES) program will be rewritten and modified for use on the data base software FoxPro 2.5 on the Fishery Section's Macintosh computers. Modifications expected in the GOES will: (1) enable the program to produce more accurate expansions that factor in days in which a given method occurred but no interviews were obtained; (2) produce separate estimates for shallow- and deepwater bottomfisheries; and (3) use additional location codes to more accurately distinguish between trips that include or exclude offshore banks. The software and hardware itself will greatly reduce the time needed to produce expansions as well as greatly reduce risks of input or transcription errors by making it possible to save subsets and files without having to re-enter variables, and by eliminating the need for dumping compiled summary data on other software in order to produce tables and charts. This will make it possible to quickly and efficiently examine many aspects of the data base that are impractical to exam under the current system as well as make it possible to re-expand the historic data base using more accurate information on participation.
2. Studies of the major shallow water bottomfish species *Epinephelus fasciatus*, *Variola louti*, and *Lethrinus rubrioperculatus* that examine reproduction and ecology as well as length-frequency distributions to be initiated under the D-J funded project "Studies of Recreationally Important Reef Fish" (Project No. F-1R Job F-1).

3. An increase in staffing to adequately cover the Agat Marina and other launch sites while maintaining the current level of coverage at the Agana Boat Basin.

Therefore, we recommend that this job and sampling techniques continue to be refined or expanded as necessary, and that historic annual estimates of catch and effort be reassessed. We also recommend that staff fisheries biologists continue to work closely with NMFS personnel in improving the efficiency and accuracy of our computerized data analysis techniques, and that they take an active roll in regional management activities through the Council and other regional organizations.

PROGRAM COSTS

The estimated cost of the Offshore Fisheries Survey Project is \$87,070.

Report prepared by Robert F. Myers

APPENDIX 1

Guam International Fishing Derby

PERIOD COVERED: 22-24 July, 1994

INTRODUCTION

The eighteenth Guam International Fishing Derby (GIFD) was held on July 22, 23, and 24, 1992. Awards were presented to the anglers who landed the first, second, third, fourth, fifth, and sixth heaviest fishes of the following species: blue marlin (*Makaira mazara*), yellowfin tuna (*Thunnus albacares*), wahoo (*Acanthocybium solandri*) and mahimahi (*Coryphaena hippurus*). Records were kept in an "other species" category by the DAWR.

PROCEDURES

DAWR biologists were present at both check-out/check-in stations, the Agana Boat Basin and the Agat Marina. A log of all departing and returning boats was kept and as many returning boats as possible were intercepted and interviewed.

Parameters of participation and effort were determined by using daily averages in place of missing data wherever possible. This was done for number of fishermen, number of lines fished, and "down time" when determining hours spent fishing. For these parameters, daily data was missing for approximately 8 to 21% of returning boats, depending on the parameter and day. The number of boat trips and boat hours was known since a log of all departing and returning boats was kept.

Determination of catches required a subjective appraisal of what species were likely to be present in non-intercepted boats. Average daily catch rates by species were assigned to non-intercepted boats in order to determine daily totals. With the exception of the shortbill spearfish, catches of non-intercepted boats were assumed to contain only non-derby species. Eighty-five percent of returning boats were intercepted.

RESULTS

Participation

One hundred and four boats made 271 fishing trips during the course of the derby. This was a decrease of 17% for the number of boats and 21% for the number of trips from the record numbers posted last year. There were an average of 3.0 anglers pulling an average of 4.3 lines per trip. The mean time spent on the water was 8.8 hours per boat trip, of which 7.8 hours were spent fishing.

Catch

A total of 4,222.0 kg of derby species were landed. This was a 58% increase over last years catch which was the lowest since 1983, but was less than the derby catches during the period from 1987-91 (Tables 2, 3). The bulk (72%) of the catch consisted of blue marlin (3,041.8 kg). Including the by-catch of five species, which accounted for 64% of the fishes caught but only 23% of the weight, 600 fish weighing 5,450.7 kg were caught. The bulk of the bycatch consisted of skipjack tuna (1,050.6 kg) with the remainder

Table 1. Daily participation, effort and catch in the eighteenth annual Guam International Fishing Derby. Weights are expressed in kilograms.

	DAY 1 JUL 22	DAY 2 JUL 23	DAY 3 JUL 24	DERBY TOTALS
Number of boats	86.00	92.00	78.00	104.00
Number of boat trips	92.00	97.00	82.00	271.00
Number of fishermen*	273.00	282.00	266.00	821.00
Average number of men per boat	3.00	2.90	3.30	3.00
Number of lines fished**	397.00	412.00	348.00	1,157.00
Average number of lines per boat	4.30	4.20	4.30	4.30
Boat hours	802.30	889.60	685.70	2,377.60
Fished hours	715.90	792.10	610.00	2,118.00
Average boat trip length	8.70	9.20	8.50	8.80
Average time spent fishing	7.80	8.20	7.50	7.80
Fisherman hours	2,058.70	2,343.70	1,982.00	6,384.40
Line hours	3,075.50	3,463.80	2,643.60	9,182.90
Number of fish landed	213.00	223.00	164.00	600.00
Catch landed (kg)†	1,923.30	1,840.70	1,686.70	5,450.60
kg/boat	22.40	20.00	21.60	52.40
kg/boat trip	20.90	19.00	20.60	20.10
kg/boat hour fished	2.69	2.32	2.77	2.57
kg/person hour	0.93	0.79	0.85	0.85
kg/line hour	0.63	0.53	0.64	0.59
TOTALS	9,708.05	10,503.04	8,616.06	28,566.91

* Daily total assumes no turnover of participants for boats with multiple trips per day; derby total is given as 100% turnover.

** Artificial data based on the average number of lines per boat interviewed multiplied by the number of boats.

† Includes incidental catch of non-derby species.

Table 2. Daily catch composition for the eighteenth annual Guam International Fishing Derby. Weights are expressed in kilograms.*

SPECIES	DAY 1 - JUL 22			DAY 2 - JUL 23			DAY 3 - JUL 24			DERBY TOTALS		
	NUMBER CAUGHT	TOTAL WT.	AVE WT.	NUMBER CAUGHT	TOTAL WT.	AVE WT.	NUMBER CAUGHT	TOTAL WT.	AVE WT.	NUMBER CAUGHT	TOTAL WT.	AVE WT.
Derby												
Blue marlin	17	1,127.5	66.3	15	954.1	6.3	13	951.8	73.2	45	3,033.4	67.4
Shortbill spearfish	1	8.4	7.7							1	8.4	7.7
Yellowfin tuna	12	59.1	4.9	24	112.3	4.7	20	94.2	4.7	56	265.6	4.7
Wahoo	34	265.9	7.8	31	260.6	8.4	47	352.0	7.5	112	878.5	7.8
Mahimahi	2	16.8	8.4	3	42.2	14.1				5	36.0	7.2
Non-derby												
Silky shark	1	64.6	64.6							1	64.6	64.6
Bigeye trevally							1	5.7	4.8	1	5.7	4.8
Rainbow runner	12	21.8	1.8	1	0.5	0.4	1	1.1	0.9	14	23.4	1.7
Skipjack tuna	130	342.9	2.6	141	454.1	3.2	75	253.8	3.4	346	1,050.8	3.0
Baracuda	4	16.3	3.7	8	39.9	5.3	7	28.1	3.9	19	84.2	4.4
TOTALS	213	1,923.3	9.0	223	1,840.7	8.3	164	1,686.7	10.3	600	5,450.6	9.1

* Figures for non-derby species and shortbill spearfish are based on an expansion that accounts for returning vessels that were missed. Expanded numbers of fishes are rounded to the nearest whole number. In cases in which a single fish of a species was caught, the expanded weight may exceed the average weight of that fish.

Table 3. Catch comparison for all Guam International or Marianas Fishing Derbies¹. Weights are expressed in kilograms (1 kg=2.2046 lbs).

	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994
BLUE MARLIN																		
no. caught	9	9	6	12	34	12	13	47	17	47	44	58	84	63	61	41	26	45
total weight	932.9	511.1	702.9	727.0	2,005.0	852.2	964.2	2,840.4	1,659.0	2,859.0	4,088.2	3,831.9	5,207.2	3,369.0	3,102.3	2,680.4	1,805.5	3,033.4
ave. weight	103.6	56.8	117.2	60.6	59.0	71.0	74.2	60.4	97.6	60.8	93.2	66.1	62.0	53.5	50.8	65.4	69.4	67.4
winning fish	191.8	75.3	237.2	138.8	145.1	132.0	199.1	215.4	177.8	173.7	188.2	155.3	182.2	133.8	111.1	152.4	162.6	244.3
YELLOWFIN TUNA																		
no. caught	18	11	34	50	109	205	100	59	137	71	116	161	81	81	102	99	103	56
total weight	239.9	254.9	637.2	307.9	1,156.0	2,376.9	1,105.7	388.8	1,058.0	405.9	858.5	848.5	385.2	546.3	1,129.1	891.2	659.5	265.6
ave. weight	13.3	23.2	18.7	6.2	10.6	11.6	11.1	6.6	7.7	5.7	7.4	5.3	4.8	6.8	7.9	9.0	6.4	4.7
winning fish	46.3	56.7	67.6	51.2	47.6	61.2	55.8	51.7	45.8	45.8	26.8	44.9	21.5	39.9	57.8	29.5	57.9	24.9
WAHOG																		
no. caught	7	9	11	12	60	33	36	46	98	16	31	72	59	34	40	38	19	112
total weight	90.7	102.0	116.1	161.0	542.9	263.9	359.6	466.2	921.5	136.5	314.3	567.4	588.1	249.7	316.7	322.0	160.3	878.5
ave. weight	13.0	11.4	10.5	13.4	9.0	8.0	10.0	10.1	9.4	8.5	10.1	7.8	10.0	7.3	7.9	8.5	8.4	7.8
winning fish	22.2	19.0	19.5	23.6	16.8	22.7	24.5	21.3	23.6	17.7	16.8	22.4	17.9	17.6	24.0	20.0	31.4	21.3
MAHIMAH																		
no. caught	2	4	5	3	1	14	33	0	14	7	3	5	7	25	11	23	12	5
total weight	13.6	26.3	52.6	39.5	0.9	63.5	195.0	0.0	76.6	61.7	39.9	12.2	36.9	121.6	107.8	131.6	39.2	36.0
ave. weight	6.8	6.6	10.5	13.1	0.8	4.6	5.9	0.0	5.5	8.8	13.4	2.4	5.3	4.9	9.8	5.7	3.3	7.2
winning fish	9.1	9.1	15.0	15.9	0.9	15.0	10.9	0.0	15.0	14.5	15.4	4.3	18.4	10.8	18.5	9.1	7.7	17.8
DERBY SPECIES																		
no. caught	36	33	56	77	177	291	182	152	266	141	103	296	233	205	214	202	161	218
total weight	1,277.6	894.3	1,508.4	1,235.4	3,704.8	3,556.9	2,624.5	3,695.2	2,716.1	3,463.5	5,220.9	5,260.0	6,273.8	4,316.6	4,655.9	4,059.6	2,676.5	4,222.0
most per boat											57	42	26					
TOTAL CATCH³																		
no. caught							281	336	427	237	488	993	562	623	412	531	359	600
total weight							3,277.6	4,365.1	4,370.1	3,794.1	6,668.5	8,188.4	7,969.8	5,646.8	5,203.9	5,040.0	3,153.9	5,450.7

¹Based on returned catch reports for 1977 to 1983, but includes known catches of principle derby species and estimated catches of non-derby species expanded for non-reporting boats for 1984 to present. Only the principal derby species are reported for 1977 to 1982.

²Third day of derby cancelled; all totals based on 2 days fishing.

³Includes the following billfish species that are potentially eligible for prizes, but were too small to qualify although they counted towards the greatest total catch in years in which a prize for that category was awarded: 2 sailfish weighing a total of 56.4 kg in 1980; 1 sailfish weighing 29.9 kg in 1990; 1 sailfish weighing 34.5 kg in 1992; 1 shortbill spearfish weighing 12.0 kg in 1993; and 1 shortbill spearfish weighing 7.7 kg in 1994.

Table 4. Effort, catch, and catch rates by area for the eighteenth annual GIFFD. Effort is based on the number of boat trips in which area fished was reported and includes all boats known to have fished within a given area. A small number of catches from unspecified areas are not included.

Area	Effort (number of boat trips)	Blue marlin			Yellowfin tuna			Wahoo			Mahimahi			Blue marlin			Yellowfin tuna			Wahoo			Mahimahi		
		no.	kg	no.	no.	kg	Catch ¹	no.	kg	no.	no.	kg	no.	no.	kg	no.	kg	no.	kg	no.	no.	kg	no.	kg	no.
North	142	23	1,662.8	30	136.1	55	432.2	1	0.7	0.16	11.7	0.21	1.0	0.39	3.0	0.01	<0.1								
Guam ²	106	6	386.9	2	10.6	13	82.8	1	0.7	0.06	3.6	0.02	0.1	0.12	0.8	0.01	<0.1								
Banks	104	17	1,276.0	24	112.6	36	309.5	-	-	0.16	12.3	0.23	1.1	0.35	3.0	-	-								
South	86	20	1,273.5	26	129.5	54	396.4	3	34.6	0.23	14.8	0.30	1.5	0.63	4.6	0.03	0.4								
Guam ³	63	2	112.7	1	4.5	6	46.2	2	16.8	0.04	2.1	0.02	0.1	0.11	0.9	0.04	0.3								
Banks	66	18	1,160.8	25	124.9	48	350.2	1	17.8	0.27	17.6	0.38	1.9	0.73	5.3	0.02	0.3								
Total	221	43	2,936.4	56	265.6	109	828.6	4	35.3	0.19	13.3	0.25	1.2	0.49	3.7	0.02	0.2								

¹Catch from unspecified areas on trips in which the areas fished were indicated are divided equally among areas fished resulting in fractions for certain areas.

²Orote Pt. to Pati Pt.

³Orote Pt. to Inarajan.

consisting of 178.1 kg of silky shark, bigeye trevally, rainbow runner, kawakawa, and barracuda.

Mean catch rates were among the highest in derby history, and more than twice those of last year: 20.1 kg per boat per trip and 2.6 kg per boat-hour fished. Like the overall catch rate, the catch rates for blue marlin and wahoo were relatively high, but the catch rates for yellowfin tuna and mahimahi were low. The catch rate for blue marlin greatly exceeded those for all other derby species (1.43 vs ≤ 0.41 kg/boat-hour fished) and was more than twice that of last year's derby.

Forty-five blue marlin, weighing 3,033.4 kg, were landed during the 1994 GIFD. The mean weight of 67.4 kg was close to those of the last two derbies, but the 244.0 kg winning fish was a new derby record.

Fifty-six yellowfin tuna weighing 265.6 kg were landed, the lowest total since 1978 when considerably fewer boats participated. The mean weight of 4.7 kg was also the lowest in derby history, and the 24.9 kg winning fish was the second smallest in derby history.

A record 112 wahoo weighing 878.5 kg were landed with a mean weight of 7.8 kg. However, the winning fish of 21.3 kg was exceeded during ten of the previous 17 derbies.

Five mahimahi weighing 36.0 kg were landed. This low catch is typical of July. However, the 17.8 kg winning fish was the third largest in derby history.

Fishing areas

Useable locality data was obtained from 82% of the returning boat trips. This made it possible to compare catches and catch rates by area (Table 4). More boats fished north of the Agana Boat Basin than south of it (142 vs 86 reported trips). This was typical of most days and due to the closer proximity of offshore banks to the Agana Boat Basin and the closer proximity of the Agana Boat Basin to the bulk of the island's population. Most of the boats (73%) the boats that fished to the north fished the northern banks while most of the boats fishing to the south (77%) fished the southern banks. Although slightly more fish were caught in the north, catch rates were higher in south. The pattern of higher overall catch rates in the south was consistent with six of the seven preceding years. However, the record derby marlin was caught to the north, at Rota Banks.

ACKNOWLEDGEMENTS

The fisheries staff of the Division of Aquatic & Wildlife Resources (DAWR) wish to thank the competing anglers, the Guam Fishermen's Cooperative, and members of the eighteenth GIFD derby committee for their cooperation and assistance in providing the information that made this report possible. This cooperation not only makes our job easier and more enjoyable, but insures a more accurate collection of data and better information for the fisherman.

Report prepared by Robert F. Myers

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-2
SUB-PROJECT NO.: F-1
STUDY NO.: 1
JOB NO.: 2

STUDY 1: Fisheries Participation, Effort, and Harvest Surveys (2430)

JOB TITLE: Inshore Fisheries Survey

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

Monthly inshore fisheries surveys were conducted along Guam's shoreline from October, 1993 to September, 1994. The total estimated inshore fisheries catch for this time period was 38.2 mt (metric tonnes), 89% of which were finfish (excluding mañāhak). Hook and line was the most practiced method accounting for 59% of the total participation* or 28,478 participants. In terms of catch rate, surround netting was the most successful daytime method, yielding approximately 4.2 kg/gear-hour (gh) and a harvest of 1.5 mt, and drag netting was the most successful nighttime fishing method, yielding approximately 9.2 kg/gh and a harvest of 0.3 mt. Hook and line was the most successful method in terms of catch, yielding approximately 0.3 kg/gh and a harvest of 9.9 mt. The seasonal mañāhak fishery, accounted for approximately 31% of the total finfish harvest or 17.5 mt.

Aerial Survey

The aerial survey report is included in Appendix 1.

BACKGROUND

Effective management of Guam's inshore fishery resources requires accumulating data on the types of fishing methods used, fishing pressure, and annual catch. In order to identify trends in fishing participation, effort, and catch, the Division of Aquatics and Wildlife Resources (DAWR) has been monitoring marine fishing activities since the early 1960's. Over this period of time, survey and analysis methodologies have changed in response to fluctuations in budget and staff. In the last several years, however, field survey techniques have been expanded and refined, while estimates of Guam's recreational / subsistence fishing activities have come to be based on more reliable data analysis techniques.

OBJECTIVES

1. To establish baseline catch and effort data for reef fish species necessary to develop a fisheries management plan for Guam.
2. To gather limited biological data that will add to a long-term historical database on Guam's fish species, which can be used to identify fisheries that require more intense research for management purposes.

* All participation and effort statistics except total harvest exclude seasonal fisheries data.

PROCEDURES

During FY94, day and night "inshore participation" surveys were conducted on four randomly selected days per month. These surveys entailed making visual observations of fishermen participation that included the reef zones and general locations that were fished within the more readily accessible portions of Guam's coastline (Figure 1, locations 1-71). Based on data collected during nine non-consecutive years of aerial surveys conducted between FY63 and FY79, approximately 85% of Guam's inshore fishing activities is known to occur within this area. The starting location for each survey was selected at random and the "clockwise or counterclockwise" direction of driving was alternated between surveys. Observations were made while driving the route once without backtracking. These methods were applied for both day and night participation surveys.

During FY94, four "inshore-catch" survey days were selected per month. During these survey days, fishermen-intercept interviews were conducted to gather catch, effort, and species composition data for both day and night fishing. The day survey covered a six-hour interval (beginning at 0630 h) and the night survey covered a five-hour interval (beginning at 1900 h). Only one of three survey regions (Fig. 1) selected for each "inshore-catch" day and fisheries data collection, was restricted to that region. However, because of infrequently interviewed methods (e.g., surround net), representative samples were sometimes difficult to obtain. Therefore, if a particular fishing method was not observed within the selected survey area during the survey, one or both of the other two areas could be surveyed for that method.

Seasonal data on the bigeye scad (atulai) and the juveniles of fusiliers (achenchon), goatfish (ti'ao), jacks (i'e'), and rabbitfish (mañâhak), were acquired through actual participation and "inshore catch" surveys.

Because the coastal fishing participation and range has steadily increased over recent years, aerial surveys were reinstated around Guam during FY90 in order to update islandwide participation estimates. Aerial surveys for this reporting period were begun in October 1993 and conducted twice monthly. The surveys were performed on regularly scheduled participation days (one weekday / weekend) and began on the hour, rotating through from 0800 h to 1200 h for each subsequent survey. Visual observations of the fishing methods, participants, gear units, and areas fished were recorded as done in the inshore participation survey. Other data collected during these flights include observations of marine mammals, turtles, sharks, offshore fishing activity, FAD (fish aggregation device) use, and other incidental information.

The FY94 inshore harvest estimates were calculated by a computer software package for Macintosh known as the Fourth Dimension database program (4D). The 4D program utilizes formulae described in the FY83 report (Project FW-2R-20, Sub-Project F, Study F-1, Job 2).

RESULTS

During FY94, the estimated inshore harvest for day, night, and seasonal fishing around Guam was 55.7 mt. Finfish accounted for 89% of total harvest or 38.2 mt (excluding mañâhak). The seasonal mañâhak harvest was estimated at 31% of the total finfish harvest or 17.5 mt. The total fish catch (finfish and non-finish, excluding mañâhak) resulted from a total effort of 162,863 person-hours (ph) and 165,324 gh. Overall, approximately 0.23 kg/gh of fish were harvested.



Figure 1. Inshore Fisheries "Participation Survey" Route and Location Codes.

CATCH

Hook and line fishing yielded the largest overall finfish catch with 9.9 mt or 29% of the total fish harvest. Gill netting was second with 9.3 mt or 27%, while cast netting was third with 7.4 mt or 22%, and spear snorkel was fourth with 5.4 mt or 16% of the total harvest (Table 1).

Table 1. Combined estimated inshore participation, effort, and total harvest (kg) for all methods during the day and night in FY94.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE†
Hook & Line	28,478	30,992	14,130	112,688	123,459	9,958	9,915	33	0.31 wed
Cast Net	6,946	5,912	5,427	17,443	14,849	7,432	7,431	1	0.69 wed
Gill Net	6,639	3,503	2,511	19,791	14,852	9,514	9,253	261	0.77 wd
Surround Net	266	90	90	1,091	377	1,549	1,549	0	4.19 wed
Spear Snorkel	4,328	4,235	2,672	8,805	8,610	8,488	5,360	3,128	1.34 wd
Spear Scuba	176	176	90	169	169	59	59	0	0.73 wen
Drag Net	264	109	109	632	289	388	388	0	9.24 wen
Hooks & Gaffs	643	823	273	1,340	1,815	509	0	509	0.29 wed
Other††	389	389	294	904	904	267	61	216	4.14 wd
TOTAL	48,129	46,229	25,596	162,863	165,324	38,164	34,016	4,148	0.23

†CPUE summary derives the greatest weekday (wd), weeknight (wn), weekend day (wed), and weekend night (wen) from Tables 2 and 3. The greatest CPUE value for hook and line was region 3.

††Other Methods usually includes: gleaning, hand nets, traps, and spears.

The top three daytime methods accounted for approximately 85% of the total day harvest and approximately 59% of the combined total harvest (Table 2). Cast netting accounted for the most finfish with 7.4 mt or 31% of the day harvest. Gill netting was second with 6.8 mt or 29%, while hook and line fishing was third with 5.9 mt or 25%, and spear snorkel was fourth with 1.9 mt or 8% of the total day harvest.

Table 2. Combined estimated inshore participation, effort, and total harvest (kg) for all methods during the day in FY94.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE†
Hook & Line	16,873	18,438	9,467	69,103	76,530	5,939	5,939	0	0.31 wd
Cast Net	6,946	5,912	5,427	17,444	14,849	7,432	7,431	1	0.69 wed
Gill Net	4,055	2,274	1,628	19,791	11,158	6,981	6,769	212	0.77 wd
Surround Net	236	82	82	1,060	369	1,544	1,544	0	4.19 wed
Spear Snorkel	1,860	1,784	1,516	4,086	3,923	4,439	1,869	2,570	1.34 wd
Spear Scuba	0	0	0	0	0	0	0	0	0.0
Drag Net	185	93	93	434	249	89	89	0	0.52 wed
Hooks & Gaffs	643	823	273	1,340	1,815	509	0	509	0.29 wed
Other††	311	311	264	415	415	251	60	191	4.14 wd
TOTAL	31,109	29,715	18,750	113,672	109,307	27,183	23,700	3,483	0.25

†CPUE summary derives the greatest weekday (wd) and weekend day (wed) from Table 2. The greatest CPUE value for hook and line was region 3.

††Other Methods usually includes: gleaning, hand nets, traps, and spears.

The top three nighttime methods accounted for approximately 96% of the total night and approximately 29% of the combined total harvests (Table 3). Hook and line fishing accounted for the most finfish caught with 4.0 mt or 39% of the total night harvest and spear snorkel was second with 3.5 mt or 34%. Gill netting was third with 2.5 mt or 24% and drag netting was fourth with 0.3 mt or 3% of the total night harvest.

Table 3. Combined estimated inshore participation, effort, and total harvest (kg) for all methods during the night in FY94.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	Finfish	Inverts	CPUE†
Hook & Line	11,604	12,554	4,663	43,585	46,929	4,009	3,976	33	0.16 wn
Cast Net	0	0	0	0	0	0	0	0	0.0
Gill Net	2,584	1,230	883	8,038	3,694	2,533	2,484	49	0.73 wen
Surround Net	31	8	8	31	8	5	5	0	0.65 wn
Spear Snorkel	2,468	2,451	1,156	4,719	4,687	4,049	3,491	558	1.12 wn
Spear Scuba	176	176	88	169	169	59	59	0	0.73 wen
Drag Net	79	16	16	198	40	299	299	0	9.24 wen
Hooks & Gaffs	0	0	0	0	0	0	0	0	0.0
Other††	78	78	30	489	489	26	1	25	0.82 wn
TOTAL	17,020	16,513	6,844	57,228	56,015	10,980	10,315	665	0.20

†CPUE summary derives the greatest weeknight (wn) and weekend night (wen) from Table 3. The greatest CPUE value for hook and line was regions 1 and 2.

††Other Methods usually includes: gleaning, hand nets, traps, and spears.

EFFORT

Hook and line fishing was the most practiced fishing method based on the total participation (Table 1), accounting for 28,478 persons or approximately 59% of the total participation. Cast netting was the second most practiced method overall accounting for 6,946 participants or 14% of the total participation, while gill netting followed in third with

6,639 participants or 14% of the total participation. The rank order for day fishing participation placed hook and line first with 16,873 or 54% participants (Table 2). Cast netting and gill netting placed second and third respectively with 6,946 or 22% and 4,055 or 13% of the participants. Hook and line fishing remained the most practiced night fishing method with 11,604 participants or 68% of night participation (Table 3). The second most practiced method was gill netting with 2,584 participants or 15%, while spear snorkel followed in third with 2,468 participants or 15% of night participation.

CATCH PER UNIT EFFORT (CPUE)

Surround netting had the highest daytime CPUE of 4.19 kg/gh for weekend day fishing, while other methods of fishing, e.g., gleaning and hand netting, followed in second with 4.14 kg/gh, and spear snorkel was third with 1.34 kg/gh. (Tables 1 and 2). Drag netting had the highest nighttime CPUE of 9.24 kg/gh for weekend night fishing, while spear snorkel followed in second with 1.12 kg/gh, and other methods of fishing was third with 0.82 kg/gh (Tables 1 and 3).

The information concerning effort and harvest for methods not discussed are included in the summary Tables 1-3. Other nearshore fisheries harvests on Guam, including spearfishing with snorkel and scuba gear by boat, are recorded in the FY94 Offshore Fisheries Report (Study F-1, Job 1).

SPECIES COMPOSITION

The expanded species composition for the day and night efforts were calculated for FY94. The top non-seasonal reef species caught was the scribbled rabbitfish, *Siganus spinus*, with 6.2 mt or 24% of the finfish total and *Mulloides ti'ao* was the top seasonal species caught with 0.95 mt or 2.8% of the finfish total. Siganidae was the top family of finfish harvested with 6.8 mt or 20.02% of the combined harvest in FY94 (Table 4).

The top daytime species remained the same with *Siganus spinus* accounting for 5.7 mt or 24.22% (81% by surround net and 49% by cast net) and *Mulloides ti'ao* with 0.95 mt or 4.01% of the day total. Siganidae topped family day harvest with 6.2 mt or 26.10% (Table 5).

The top night-caught species was the white tip reef shark, *Triaenodon obesus*, with 1.3 mt or 13% of the night total (32% by hook and line), which was 1.95 times greater than second-most caught species, *Mulloides flavolineatus*, with 0.66 mt or 6.38%. Larger reef fish species, especially sharks, tend to skew the expansion estimates due to their significantly greater sizes. Acanthuridae topped the night family harvests with 1.5 mt or 14.62% (Table 6).

Table 4. FY94 combined day and night catch composition for the top ten species and families harvested. Juvenile *Mulloides flavolineatus* (ti'ao ≥ 100 mm), and *Siganus spinus* (mañāhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the day and night catch (34,016 kg)

SPECIES	Harvest		FAMILY	Harvest	
	kg	%		kg	%
<i>Siganus spinus</i>	6,229.34	18.31	Siganidae	6,810.35	20.02
<i>Mulloides flavolineatus</i>	1,983.86	5.83	Acanthuridae	4,974.79	14.62
<i>Acanthurus triostegus</i>	1,856.24	5.46	Mullidae	3,812.33	11.21
<i>Carcharhines amblyrhynchos</i>	1,801.94	5.30	Mugilidae	2,847.98	8.37
<i>Naso unicornis</i>	1,522.57	4.48	Carangidae	2,423.27	7.12
<i>Triacodon obesus</i>	1,287.92	3.79	Lethrinidae	1,986.94	5.84
<i>Liza vaigiensis</i>	1,240.07	3.65	Carcharhinidae	1,801.94	5.30
<i>Crenimugil crenilabis</i>	979.40	2.88	Scaridae	1,487.36	4.37
<i>Lethrinus harak</i>	970.43	2.85	Hemigaleidae	1,287.92	3.79
<i>Mulloides ti'ao</i>	951.65	2.80	Serranidae	992.84	2.92
TOTAL ANNUAL COMBINED CATCH	18,823.42	55.34		28,425.72	83.57

Table 5. FY94 combined day catch composition for the top ten species and families harvested. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (*Caranx i'e'* ≤ 200 mm), *Mulloides flavolineatus* (ti'ao ≤ 100 mm), and *Siganus spinus* (mañāhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the day and night catch (23,700 kg)

SPECIES	Harvest		FAMILY	Harvest	
	kg	%		kg	%
<i>Siganus spinus</i>	5,740.84	24.22	Siganidae	6,184.97	26.10
<i>Carcharhines amblyrhynchos</i>	1,801.94	7.60	Acanthuridae	3,467.01	14.63
<i>Acanthurus triostegus</i>	1,351.71	5.70	Mugilidae	2,618.66	11.05
<i>Mulloides flavolineatus</i>	1,325.92	5.59	Mullidae	2,599.64	10.97
<i>Liza vaigiensis</i>	1,226.30	5.17	Carcharhinidae	1,801.94	7.60
<i>Naso unicornis</i>	1,194.00	5.04	Carangidae	1,434.27	6.05
<i>Crenimugil crenilabis</i>	953.60	4.02	Lethrinidae	1,207.09	5.09
<i>Mulloides ti'ao</i>	951.10	4.01	Scaridae	615.00	2.59
<i>Lethrinus harak</i>	836.45	3.53	Serranidae	551.87	2.33
<i>Caranx i'e'</i>	576.60	2.43	Gerreidae	482.55	2.04
TOTAL ANNUAL COMBINED CATCH	15,958.46	67.34		20,963.00	88.45

Spearfishing with scuba did not account for a significant amount of fish caught during the survey period, despite the high catch rate using this method. The main reason for this occurrence is that a greater percentage of scuba spearfishermen are difficult to encounter during a survey and many of them go to the outer reefs, e.g., Double Reef or outer Cocos Lagoon from boats than by shore (Study F-1, Job 1).

Table 6. FY94 combined night catch composition for the top ten species and families harvested. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (*Caranx i'e'* $\leq$ 200mm), *Mulloides flavolineatus* (ti'ao $\leq$ 100mm), and *Siganus spinus* (mañahak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the day and night catch (15,664 kg)

SPECIES	Harvest		FAMILY	Harvest	
	kg	%		kg	%
<i>Triaenodon obesus</i>	1,287.92	12.49	Acanthuridae	1,507.78	14.62
<i>Mulloides flavolineatus</i>	657.94	6.38	Hemigaleidae	1,287.92	12.49
<i>Acanthurus triostegus</i>	504.53	4.89	Mullidae	1,212.69	11.76
<i>Siganus spinus</i>	488.50	4.74	Carangidae	989.00	9.59
<i>Epinephelus merra</i>	424.72	4.12	Scaridae	872.36	8.46
<i>Parupeneus barberinus</i>	382.76	3.71	Lethrinidae	779.85	7.56
<i>Sphyræna barracuda</i>	373.82	3.62	Siganidae	625.38	6.06
<i>Caranx i'e'</i>	363.88	3.53	Labridae	498.70	4.83
<i>Naso lituratus</i>	346.97	3.36	Serranidae	440.97	4.28
<i>Lethrinus olivaceus</i>	335.65	3.25	Sphyrænidae	421.57	4.09
TOTAL ANNUAL COMBINED CATCH	5,166.69	50.09		8,636.22	83.72

Mañahak and Atulai Harvests

FY94 marked an exceptional year for mañahak (ha'tang or *Siganus spinus* and lessso' or *S. argenteus*). The estimated catch for mañahak for selected areas in April and May 1994 was 17.5 mt or 31% of the total finfish harvest. The harvest estimates for these fish were determined independently from the 4D program due to the sporadic nature of this fishery (Table 7).

The atulai (*Selar crumenophthalmus*) season was marginally successful with 0.4 mt or 1% of the total catch for FY94. The achenchon (*Pterocaesio* spp.) run did not occur in FY94.

Table 7. FY94 mañahak harvest during April and May 1994. Catch data (kg) was obtained from the following locations: E. Agaña Bay; Agaña Boat Basin; Tumon Bay; Gun Beach; Asan Beach; Merizo Pier; and Gâdao-Fofos.

METHOD	Persons	Gears	Trips	Per-Hrs	Gear-Hrs	Catch	CPUE
				ph	gh	kg	kg/gh
Cast Net	316.0	320.0	320.0	1,924.1	1,880.1	8,850.0	4.71
Surround Net	124.0	18.0	18.0	670.5	107.9	8,650.0	80.17
TOTAL	440.0	338.0	338.0	2,594.6	1,988.0	17,500.0	8.80

Method Harvests

The top harvest of finfish species for hook and line method was calculated for FY94 (Table 8). The gray reef shark, *Carcharhinus amblyrhynchos*, ranked first with 1.8 mt (30.34%) for day, while the whitetip reef shark, *Triaenodon obesus*, was ranked first with 1.3 mt (32.39%) for night. Several large sharks skewed the expansion estimates for hook and line in FY94.

Table 8. FY94 combined day and night catch composition for the top ten species harvested by hook and line method. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (*Caranx i'e'* $\leq$ 200mm), and *Siganus spinus* (mañāhak), are listed separately from the intermediate to adult size classes. Finfish harvest percentages were derived from the total day (5,939 kg) and night (3,976 kg) hook and line catch.

Day Species	Harvest		Night Species	Harvest	
	kg	%		kg	%
<i>Carcharhinus amblyrhynchos</i>	1,801.94	30.34	<i>Triaenodon obesus</i>	1,287.92	32.39
<i>Naso unicornis</i>	839.50	14.14	<i>Sphyræna barracuda</i>	373.82	9.40
<i>Caranx i'e'</i>	421.85	7.10	<i>Lethrinus olivaceus</i>	335.65	8.44
<i>Lethrinus harak</i>	275.25	4.63	<i>Selar crumenophthalmus</i>	273.99	6.89
<i>Caranx papuensis</i>	254.14	4.28	<i>Lethrinus xanthochilus</i>	187.15	4.71
<i>Liza vaigiensis</i>	239.91	4.04	<i>Caranx papuensis</i>	152.68	3.84
<i>Epinephelus merra</i>	198.33	3.34	<i>Epinephelus merra</i>	118.85	2.99
<i>Siganus spinus</i>	179.90	3.03	<i>Lutjanus monostigmus</i>	91.29	2.30
<i>Naso lituratus</i>	176.29	2.97	<i>Lethrinus harak</i>	85.59	2.15
<i>Lethrinus olivaceus</i>	157.45	2.65	<i>Cheilio inermis</i>	84.24	2.12
Total Top Ten Hook & Line Catch	4,544.56	76.52		2,991.18	75.23
Total Combined Hook & Line Catch	7,535.74	76.00			

The top harvest of finfish species for gill net method was calculated for FY94 (Table 9). *Mulloidies flavolineatus* ranked first for day and night with 1.1 mt (15.61%) and 0.38 mt (15.36%) respectively. *Liza vaigiensis* ranked close to first with 0.97 mt (14.34%) for day, while *Acanthurus triostegus* ranked close to first with 0.36 mt (14.79%) for night.

Table 9. FY94 combined day and night catch composition for the top ten species harvested by gill net method. Juvenile *Caranx ignobilis*, *C. melampygous*, *C. papuensis*, and *C. sexfasciatus* (*Caranx i'e'* $\leq$ 200mm), and *Siganus spinus* (mañāhak), are listed separately from the intermediate to adult size classes. Gerres spp. are listed at the genus level due to identification problems. Finfish harvest percentages were derived from the total day (6,769 kg) and night (2,484 kg) gill net catch.

Day Species	Harvest		Night Species	Harvest	
	kg	%		kg	%
<i>Mulloidies flavolineatus</i>	1,056.64	15.61	<i>Mulloidies flavolineatus</i>	381.65	15.36
<i>Liza vaigiensis</i>	970.73	14.34	<i>Acanthurus triostegus</i>	367.47	14.79
<i>Acanthurus triostegus</i>	566.87	8.37	<i>Caranx i'e'</i>	303.84	12.23
<i>Siganus spinus</i>	451.81	6.67	<i>Parupeneus barberinus</i>	169.26	6.81
Gerres spp.	354.29	5.23	<i>Valamugil seheli</i>	151.33	6.09
<i>Lethrinus harak</i>	286.64	4.23	<i>Cheilio inermis</i>	149.59	6.02
<i>Siganus punctatus</i>	269.74	3.98	<i>Siganus spinus</i>	105.03	4.23
<i>Leiognathus equulus</i>	210.57	3.11	Gerres spp.	100.64	4.05
<i>Leptoscarus vaigiensis</i>	199.37	2.95	<i>Mulloidies vanicolensis</i>	58.23	2.34
<i>Valamugil seheli</i>	168.94	2.50	<i>Scarus sordidus</i>	55.81	2.25
Total Top Ten Gill Net Catch	4,535.60	67.01		1,842.85	74.19
Total Combined Gill Net Catch	6,378.45	68.93			

The top harvest of finfish species for snorkel spear method was calculated for FY94 (Table 10). *Ctenochaetus striatus* ranked first with 0.31 mt (16.64%) for day, while *Siganus spinus* ranked first with 0.36 mt (10.18%) for night. *Naso unicornis* ranked close to first with 0.30 mt (16.28%) for day and 0.33 mt (9.41%) at night, while *Naso lituratus* ranked second at night with 0.33 mt (9.52%).

Table 10. FY94 combined day and night catch composition for the top ten species harvested by spear snorkel method. *Scarus* spp. are listed at the genus level due to identification problems. Finfish harvest percentages were derived from the total day (1,869 kg) and night (3,491 kg) spear snorkel catch.

Day Species	Harvest		Night Species	Harvest	
	kg	%		kg	%
<i>Ctenochaetus striatus</i>	310.95	16.64	<i>Siganus spinus</i>	355.43	10.18
<i>Naso unicornis</i>	304.34	16.28	<i>Naso lituratus</i>	332.21	9.52
<i>Synanceia verrucosa</i>	234.87	12.57	<i>Naso unicornis</i>	328.57	9.41
<i>Siganus spinus</i>	180.62	9.66	<i>Scarus</i> spp.	289.64	8.30
<i>Epinephelus merra</i>	148.86	7.96	<i>Epinephelus merra</i>	256.47	7.35
<i>Acanthurus guttatus</i>	141.09	7.55	<i>Parupeneus barberinus</i>	213.50	6.12
<i>Acanthurus triostegus</i>	114.79	6.14	<i>Acanthurus triostegus</i>	137.05	3.93
<i>Scarus sordidus</i>	82.70	4.42	<i>Scarus psittacus</i>	120.68	3.46
<i>Lethrinus obsoletus</i>	53.76	2.88	<i>Naso hexacanthus</i>	117.61	3.37
<i>Lutjanus monostigmus</i>	38.87	2.08	<i>Scarus sordidus</i>	116.08	3.33
Total Top Ten	1,610.85	86.19		2,267.24	64.95
Spear Snorkel Catch					
Total Combined	3,878.09	94.15			
Spear Snorkel Catch					

Seasonal Harvests

The seasonal catch of certain juvenile fishes is widely anticipated by local fishermen. The catches of ti'ao and i'e' are usually well represented within the expansion estimates (Tables 4-6). During FY94, pulses of recruiting i'e' occurred from June - August 1994, while ti'ao catches remained relatively low throughout the year. Ti'ao (*Mulloides* spp. $\leq$ 100mm) and i'e' (*Caranx* spp. $\leq$ 200mm) ranked eighth and tenth respectively for day harvest (Table 5) and i'e' ranked eighth for night harvest (Table 6) in FY94.

Invertebrate Harvests

In addition to finfish, a number of other marine invertebrates were harvested from Guam's reefs. An estimated 2.5 mt (60% of the total invertebrate harvest) of octopus were caught island-wide during FY94. Daytime octopus harvests accounted for 2.2 mt (72% by spear snorkel, 23% by hooks and gaffs, and 6% by other methods), while nighttime harvests accounted for 0.3 mt (98% by spear snorkel, 2% by hook and line, and 0.1% by other methods) in FY94.

The second most caught invertebrate was the spiny lobster, *Panulirus penicillatus*, with an estimated 1.0 mt (23% of the total invertebrate harvest) of the island-wide catch in FY94. Daytime spiny lobster harvests accounted for 0.7 mt (82% by spear snorkel and 18% by

gill netting), while nighttime harvests accounted for 0.3 mt (100% by spear snorkel) in FY94.

Spearfishing with scuba and snorkel gear accounts for a significant amount of spiny lobster (unusually high offshore harvest in June, 1994), 7-11 crab and miscellaneous decapods, e.g., *Carpilius maculatus* and decapods, harvested at night (based on personal observations by R.F. Meyers, Study F-1, Job 1), but these species were not significantly represented in the inshore survey estimates due to the rarity of snorkel and scuba spearfishing interviews.

Other methods, e.g., gleaning and hand netting, produced an estimated 0.3 mt of finfish and invertebrates, e.g., *Zanclus cornutus* and *Grapsus albolineatus*, with a catch rate of 0.002 kg/ph of fishing effort.

RECOMMENDATION

The establishment of the 4D program has greatly reduced the time needed to compile and analyze Guam's inshore survey data. Because of this, more effort has been spent to continually upgrade our data collection procedures to ensure statistical reliability.

Initial aerial observations show that 87.2% of the participants and 87.3% of the gear-units are being surveyed on the shore participation route when compared with the island-wide count. Even though this falls within the estimated 85% from previous aerial surveys (FY63-79), it is recommended that the aerial surveys be continued. The sampling technique has improved since the initiation of the aerial surveys and with further data, an improved quantitative analysis can be done for island-wide inshore fishing effort. Comparisons with aerial participation data should be statistically compared to data obtained during the regular inshore participation in order to update the inshore expansion confidence.

Since the inshore fisheries survey provides information important for management and planning, it is recommended that this job be continued. Due to the inadequacies of the "inshore-catch" survey window (especially evening for certain methods), harvests were not representative of the actual participation and is reflected in the following catch confidence limits for daytime: spear snorkel = $\pm 45.5\%$, hooks and gaffs = $\pm 57.4\%$, and other methods = $\pm 63.5\%$; and nighttime: spear scuba = $\pm 84.3\%$, and spear snorkel = $\pm 31.9\%$ (methods not listed had confidence limits less than or equal to 20.5%). Methods rarely encountered during the day included: surround net, spear scuba, and drag net; and at night included: cast net, surround net, and hooks and gaffs, drag net, and other methods.

The FY94 mañahak season was very successful in comparison with harvests over the last five years. Future concerns lie with improved management of the jetski operations in East Agana Bay by Parks and Recreation during the mañahak runs, which will allow the maximum allowable time for fishermen to harvest the resource without interference from jetski operators.

Overall declines in annual harvests and shifts in species composition have occurred in the last ten fiscal years. Strict measures should be taken to manage the species of fish that are steadily decreasing in the overall harvest estimates, i.e., implementation of marine preserves, in order to prevent the overexploitation of our fishery resource.

PROJECT COST: The estimated cost of this project was \$81,000.

Report prepared by: Todd J. Pitlik

APPENDIX 1

INSHORE AERIAL SURVEY

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

A total of 12 "inshore aerial" surveys were conducted in FY94 for a total of 460 persons and 365 gear units. Hook and line was the most frequently encountered method with 210 persons and 209 gear units. A ratio of participants / method observed in areas outside the inshore participation route to the total number for all methods surveyed during the "inshore aerial" were calculated as variables (P_2 values) for the inshore expansion. The values ranged from 39% for weekend snorkel spear fishing to 100% for rare and night-practiced methods, e.g., surround net, SCUBA spearfishing, hooks and gaffs, drag net, and other methods.

Incidental biological sightings resulted in a total of 160 turtles, 237 dolphins, 25 sharks, 1 eagle ray, 5 stingrays, 1 manta ray, and 6 sperm whales for FY94.

BACKGROUND

Inshore fishing surveys have been conducted by the Division of Aquatics and Wildlife Resources (DAWR) since the early 1960's to monitor and collect a long-term database on the total fishing effort and catch from Guam's reefs. The "inshore-catch" and "inshore-participation" surveys were developed to collect catch and effort data in nearshore areas easily accessible by motor vehicle. In addition, the "inshore-aerial" survey was established in the early 60's and reinstated in FY90 to survey effort in areas that could not be easily accessed by a vehicle.

PROCEDURES

"Inshore-aerial" surveys were conducted twice monthly on regularly scheduled participation days (one weekday/weekend). Start times are moved up in one-hour intervals for each subsequent survey (0800-1200h), then repeated after reaching 1200h. Visual observations of areas not covered in the "inshore-participation" survey (Fig.1 locations: 22, 27, 28, 35-39, 44-50, 58, 59, 70, and 73-92) included fishing effort data. The first scheduled weekday and weekend participation survey dates of each month were selected to allow rescheduling in the event of poor weather conditions.

Each survey started in location 11 and proceeded in a clockwise direction all the way around the island to location 12 (Fig. 1). The seaward flight distance from the reef margin was 200-300m with an altitude of 170-200m. The aerial itinerary also included a semi-circular flight pattern within Cocos Lagoon and Apra Harbor. In addition, the pilot was instructed to circle over reef flat areas when it was difficult to observe or determine activity.

The aerial survey observations were sorted by method and type day (weekday / weekend). A ratio of the persons / method observed in areas outside the inshore participation route were compared to the total number of persons / method observations for the island for each

type day. The resultant P_2 values provided variables (%) that could be used to expand inshore participation values to island-wide participation values.

Other biological data collected, included incidental observations of marine mammals, turtles, sharks, and rays at or near the surface of various reef zones, e.g., Pati Point and the fore reef slope, along the aerial survey route.

The FY94 inshore harvest estimates were statistically expanded by a computer software package for Macintosh known as the Fourth Dimension database program (4D). The 4D program utilizes formulae described in the FY83 report (Project FW-2R-20, Sub-Project F, Study F-1, Job 2) to compile and expand inshore survey data for the fiscal year.

RESULTS

The most frequently encountered methods included hook and line, cast net, gill net, surround net, snorkel spear, and other methods, while hooks and gaffs, SCUBA spear, and drag net methods were less common. Ratio frequencies were highest (100%) for the least common methods, which were due to the rarity of their use during the day, e.g., SCUBA spear and drag net are primarily night methods. Hook and line, cast net, gill net, surround net, snorkel spear, SCUBA spear, hooks and gaffs, and other methods (weekday and weekend days respectively) had P_2 values (Table 1) listed as percentages: (94 / 92), (77 / 79), (89 / 98), (100 / 100), (88 / 39), (100 / 100), (100 / 100), and (71 / 100), respectively for FY94.

Table 1. P_2 values derived from aerial survey data in FY94. Ratios were calculated from a ration of method sightings within aerial locations to participation locations. Method abbreviations are listed as follows: Hook and Line (HL); Cast Net (CN); Gill Net (GN); Surround Net (SN); Spear Snorkel (SpSn); Spear SCUBA (SpSc); Hooks and Gaffs (HG); Drag Net (DN); and Other Methods (OM).

Ratios	HL	CN	GN	SN	SpSn	SpSc	HG	DN	OM
Weekday	3/51	6/20	3/25	0/2	2/14	0/0	0/0	0/0	2/5
Weekend	12/144	11/41	1/64	0/34	7/11	0/0	2/0	0/0	0/0
WD Ratio	3/54	6/26	3/28	0/2	2/16	0/0	0/0	0/0	2/7
WE Ratio	12/156	11/52	1/65	0/34	7/18	0/0	2/2	0/0	0/0
WD P_2	94	77	89	100	88	100	100	100	71
WE P_2	92	79	98	100	39	100	100	100	100

The greatest number of people fishing in participation areas during the aerial survey used hook and line on weekdays and weekends for a total of 196 and 194 persons and gear-units respectively, while hook and line was also the most frequently used method in aerial areas for a total of 15 and 15 persons and gear units respectively for FY94 (Table 2).

Table 2. Total number of people and gear units observed during aerial surveys in FY94. Method abbreviations are listed in Table 1 with weekday (WD) and weekend (WE) listed below.

Methods	Within Par Route				Outside Par Route			
	Persons		Gears		Persons		Gears	
	WD	WE	WD	WE	WD	WE	WD	WE
HL	51	144	52	142	3	12	3	12
CN	20	41	20	38	6	11	5	11
GN	25	64	11	22	3	1	1	1

SN	2	34	2	3	0	0	0	0
SpSn	14	7	14	7	2	11	2	11
SpSc	0	0	0	0	0	0	0	0
HG	0	0	0	0	0	2	0	1
OM	5	0	5	0	2	0	2	0
Total	117	290	104	212	16	37	13	36

Dolphins topped the list of the most frequently sighted marine animals during the aerial surveys with 237 sightings. The greatest monthly total of 70 dolphin sightings occurred in February. Turtles, sharks, and sperm whale sightings ranked second, third, and fourth, respectively with annual totals. The greatest monthly total of turtles were sighted in February with 44, sharks in March with 8, and sperm whales in May with 6. In addition, 5 stingrays and 1 eagle ray and manta ray were sighted in FY94 (Table 3).

Table 3. Number of turtle, dolphin, shark, ray, and whale sightings in FY94.

SPECIES	MONTHS							TOTAL
	F	M	A	M	J	J	A	
Turtle	44	20	17	10	29	17	23	160
Dolphin	70	15	15	45	0	30	62	237
Shark	3	8	0	4	5	2	3	25
Sting Ray	0	1	0	0	0	0	0	1
Eagle Ray	0	3	1	1	0	0	0	5
Manta Ray	0	0	1	0	0	0	0	1
Sperm Whale	0	0	0	6	0	0	0	6

The first four months of aerial surveys were not scheduled, due to a vacancy in the inshore fisheries biologist position. In addition, cancellations due to poor weather conditions were a slight problem for the remainder of FY94. Twelve cancellations (50%) occurred on the following weekday (WD) and weekend (WE) survey dates: WD (10/21/93, 11/16/93, 11/27/93, 12/29/93, 1/24/94, 5/18/94, and 9/27/94); and WE (10/24/93, 11/27/93, 12/12/93, 1/30/94, 2/20/94, and 9/24/94).

FLIGHT COST: \$9,500

Report prepared by: Todd J. Pitlik

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-2
SUB-PROJECT NO.: F-1
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Fisheries Data Processing. (2430)

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

During FY94 no staff were hired to fill the vacant project coordinator for this job. Since recruitment difficulties could not be overcome in finding a biologist with the necessary computer skill it was decided to pursue hiring a computer programmer.

BACKGROUND

Guam's Division of Aquatic and Wildlife Resources (DAWR) has been collecting fisheries information over the past 24 years (with only the last fifteen years of data being reliable) and, as a result, an enormous amount of fisheries management data has been accumulated. Computers have been used over the past eight years by DAWR to store and analyze this data. DAWR personnel, working closely with the National Marine Fisheries Service, have developed and purchased programs for analyzing the Division's offshore and inshore fisheries survey data.

In FY83, a program entitled the Guam Offshore Expansion System (GOES) was developed based on the current practices of offshore data analysis and, in FY85, a Guam Inshore Expansion System (GIES) was completed and tested for errors (this program underwent modifications in FY90 to take advantage of the storage capability and speed of computers that are currently available). Since this time, all data collected for the offshore and inshore fisheries surveys have been analyzed through the use of these two programs.

Job 3, Fisheries Data Processing, has been jointly funded by the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, and the Western Pacific Regional Fisheries Management Council.

OBJECTIVES

1. Computerize the DAWR's offshore and inshore marine fisheries data and transfer the finalized fisheries data files and reports to NMFS personnel in Honolulu, Hawaii for regional application.
2. Provide technical assistance to DAWR staff biologists in the form of efficient statistical analysis and report generation.

PROCEDURES

Guam's offshore fisheries survey data are analyzed by a system of computer programs known as the GOES. This programming package is a 5-step system that summarizes, sorts, and statistically expands the survey data to produce monthly and annual catch, effort, and species composition estimates. Two proportionality constants and a "total participation boat count" are calculated and manually entered into the expansion module by the user. Reports are generated by the GOES that give a breakdown of the estimated offshore harvest by gear type on a monthly and annual basis. Also, an estimated harvest by species is generated for each gear type with a corresponding percentage of the total catch for that gear type.

Guam's inshore fisheries survey data are analyzed by a programming package known as the GIES. The original GIES was a 4-step system that relies on two sets of survey data to determine an annual inshore estimated harvest. This program was modified this fiscal year so that the program can take advantage of the new computer technology in data storage and processing speed. The two sets of data are referred to as "inshore-participation" and "inshore-catch". "Inshore-participation" data consists of fishermen and gear counts obtained by biological aides when driving around the island and making observations on fishing activity within the fringing reef. "Inshore-catch" data are obtained by fishermen-intercept interviews that usually occur within a predetermined survey region. These data consist of a total catch and catch by species for each interview. Because of the apparent differences in participation and catch-per-unit-effort (CPUE) of the various gear types between daytime and nighttime fishing, a fisheries survey is conducted during each of these two time periods and the data are analyzed separately. Also, data are collected during the seasonal harvest of juvenile rabbitfish (*Siganus sp.*) and bigeye scad (*Selar crumenophthalmus*), but, because of the dissimilarities between the seasonal fisheries and the routine inshore fisheries, the two are analyzed separately.

RECOMMENDATION

Data processing is a valuable asset to the many research projects currently undertaken at DAWR. The need for data storage and retrieval, data analysis, programming and report generation has increased greatly since the installation of a computer system. Staff must be hired to reactivate this program.

PROJECT COST

There were no project costs during FY93 (\$0).

Report prepared by: Gerald W. Davis

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-IR-2
SUB-PROJECT NO: F-1
STUDY NO: 3
JOB NO: 1

STUDY 3: Studies of Guam's Recreationally-Important Fish

JOB TITLE: Biology of *Lethrinus harak* and *Lethrinus obsoletus*

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

Tabled since FY85, the project to study the biology of the emperor snapper, *Lethrinus harak*, resumed at the end of FY92 with the assignment of a new project coordinator. In FY93 the project was expanded to include another emperor species, *Lethrinus obsoletus*, after preliminary analysis of catch and tagging totals revealed that this species of emperor was caught more frequently and shared much of the same habitat with *L. harak*. Both emperor species are considered to be recreationally-important and share much in common in terms of their biology and susceptibility to current fishing pressure.

Tagging efforts continue to be concentrated in Cocos Lagoon and are conducted one day a week, sometimes more, depending on tide, lunar cycle, peak spawning periods, weather conditions and available manpower. To date, a total of 2,708 fish have been tagged since August 12, 1992; 1,612 (60%) of which were either *L. harak* or *L. obsoletus*. Of the 1,612 targeted emperors that were tagged, 27 (1.7%) have been recovered. A reduction in the amount of line-hours spent on collecting *L. harak* and *L. obsoletus*, and a continued increase in catch efficiency of these target species, was realized in FY94. An even further reduction in total line-hours and an increase in catch efficiency is also anticipated for FY95.

The tagging procedure was modified in FY93 to include field sampling for the presence of milt or eggs before a tagged fish is returned to the lagoon. Egg samples collected were immediately preserved in a 10% formalin solution and will be examined for stage of development and maturity at a later time when additional manpower is made available for this laboratory procedure. Incidental catches of other species of fish continue to be tagged, but are still not checked for milt or egg production. Although the egg sampling procedure was continued in FY94, the routine will be dropped in FY95 as part of an effort to eliminate additional traumatization of the fish after they have been tagged. The procedure was also altered in FY94 to incorporate the use of smaller tags with an algacide treatment to reduce the degree of injury to the fish caused by over-sized tags overgrown with algae. The use of even smaller algacide-treated tags is being considered for FY95.

Preliminary analysis of Lethrinid tag recoveries continue to suggest that both *L. obsoletus* and *L. harak* may have some temporal tendency to be resident to specific sea-grass areas in Cocos Lagoon. Of the twenty-seven tag recoveries made to date, all have been made within a half-mile radius of where the fish were originally caught and tagged, and usually less than three months from the time of tagging (the oldest tag recovery being a little over four months from the date the fish was tagged).

Data collected in FY94 and beyond will be compiled with FY85 data to yield more comprehensive results on the growth, reproduction, and movement of these two species of emperors. If the modified tagging procedures result in a higher recapture rate of tagged fish by the end of FY95, sufficient data may be obtained to complete the study by the end of FY96. Based on the findings of the study, recommendations may be made for the management and preservation of stocks of *L. harak* and *L. obsoletus* in Guam's waters.

BACKGROUND

The family Lethrinidae (emperors) are close relatives of snappers but differ primarily by having a maxillary completely hidden by a bare or near-bare preopercle and conical or molariform teeth on the sides of the jaws. Lethrinids also have fairly thick lips, canine teeth towards the front of the jaws, a continuous dorsal fin with X spines and 9 to 10 rays, and an anal fin with III spines and 8 to 10 rays (Myers, 1991).

Lethrinus harak, commonly known as the blackspot or thumbprint emperor, inhabits mangroves, coral rubble, shallow sandy lagoons, channels, and seagrass areas adjacent to coral reefs. It feeds on crustaceans, molluscs, polychaetes, echinoderms and small fishes, and grows to about 30 cm total length. *L. harak* have been reported to spawn in large aggregations year-round during the first five days of the lunar month in lagoons of Belau (Carpenter & Allen, 1989).

Lethrinus obsoletus, commonly known as the orange-striped emperor, is also found in seagrass beds and sand and rubble areas of lagoons and reefs. Much like *L. harak*, *L. obsoletus* feeds primarily on crustaceans, molluscs and echinoderms, and grows to about 30 cm in total length. In Belau, spawning is reported to occur at the outer reef edge during the first five days of the lunar month between November through April (Carpenter & Allen, 1989). *L. harak* has been observed by fishermen to burrow in the sand (Schroeder, 1980) which may serve as a means of escaping their predators and drag nets.

OBJECTIVE

To investigate need for management of Guam's recreationally important fish through analysis of fishing pressure, population dynamics and life history studies.

METHODS

The study of *L. harak* and *L. obsoletus* will include the following parameters: size distribution, sex ratio, spawning seasonality, lunar occurrence of spawning activity, reproductive contribution among the various size classes, growth rate and historic harvest analysis.

Tag and release of *L. harak* and *L. obsoletus* will be conducted on a once-a-week basis, sometimes more, as tide, lunar cycle, weather conditions and manpower permit. Upon capture, the fish will be measured (fork length), tagged and then released. Based on field experience, those fish that have the hook imbedded back by pharyngeal teeth or on a gill arch will be measured and recorded as "boxed fish", but not tagged or released since they usually perish after the hook removal process.

An additional procedure was incorporated in the tagging routine during FY93 and FY94 to complement previous spawning periodicity data collected back in FY85. After tagging, the fish was inverted and checked for gonad maturity before being returned to the water. Ripe males release milt with one or two light strokes from the pelvic fin to the vent. If no milt was released, a 12"-long canula, I.D. .034", O.D. .050", was inserted approximately 1 - 2

inches, and then light suction applied to draw a sample. If no milt or eggs were extracted by the procedures, the fish was labeled "NS" for "no sample".

Laboratory examinations of egg samples among the various size classes and sampling dates will be conducted to determine egg developmental stage based on diameter. Lunar phase will be noted to determine if *L. harak* and *L. obsoletus* are indeed serial spawners following a lunar cycle, and to confirm whether or not there are spawning peaks during the year. Histological data collected in FY85 will be supplemented with the above information gathered in FY93 and beyond.

RESULTS

Manpower

DAWR's efforts in FY93 and FY94 to acquire additional staff to assist part-time with the Lethrinid tagging project resulted in the hiring of two Technician I's and a Biologist I. However, the departure of the senior technician in February 1994, to attend a six-month training program off-island and the termination in April of another technician, had the net effect of reducing the actual amount of man-hours committed to the Lethrinid project to a level less than that of the previous year. Consequently, manpower committed to the Lethrinid project was used primarily to continue the weekly tagging and data collecting procedures, while little or no time was allocated to analyzing previously collected data or to laboratory work as was originally intended for FY94.

Equipment

The purchase a three-man, 14' boat, as well as all the necessary fishing equipment in mid to late-FY93, has helped considerably to increase sampling efficiency. Prior to receiving the equipment, sampling was conducted in a two-man, 12' boat and with equipment borrowed from fisheries staff. Most of the laboratory equipment necessary to conduct examinations of egg samples and histological procedures was received in FY94.

Press Release and Tagging Poster

A press release and poster were produced in FY93 to inform the general public of the tagging study and its purpose, as well as to provide instructions on what to do and who to contact if a tagged fish is recovered. Concern over the less than 2% recovery rate of tagged fish has prompted the need to reissue press releases and posters throughout FY95 to remind local anglers, especially those anglers who frequently fish Cocos Lagoon, to contact the fisheries office should they catch a tagged fish.

Inshore Catch Analysis - FY85 to FY93

Compilation of inshore catch records since FY85 for *L. harak* and *L. obsoletus* was not conducted because a replacement for the data processing specialist position left vacant in FY92 has yet to be hired. Eventual compilation and analysis of the data will provide a historic analysis of the exploitation trends of the species.

Fecundity

The FY92 recommendation to begin sampling for reproductive contribution among the size classes of females was not conducted in FY93 or FY94, primarily due to a shortage of manpower. Some Lethrinid fecundity work was initiated in FY85, however, as with much of the FY85 work, the data has yet to be compiled or subjected to statistical analyses.

Tag and Recapture Summary

DAWR tagging efforts began on August 13, 1993. A total of 58 trips were made in FY94 representing an approximately 7% increase over the 43 trips made in FY93. However, the 576 line-hours spent on the tag and recovery effort in FY93 was actually reduced in FY94 by approximately 10% to 474 line-hours. In sum, the average number of line-hours spent in FY93 was about 13 line-hours/trip, whereas in FY94 the figure was closer to approximately 8 line-hours/trip. Of particular note is the fact that the resulting catch of the two target species in FY94 was improved by about 10% in spite of the 10% reduction in actual fishing time. To date, 2,708 fish have been tagged, 1,612 (60%) of which were either *L. harak* or *L. obsoletus*. Of the 1,612 targeted emperors that were tagged, 27 (1.7%) have been recovered. Table 1 provides a breakdown of tagged and recaptured fishes according to species. A further reduction in the number of line-hours and a continued increase in catch efficiency of the target species was anticipated for FY95.

Table 1. Tagging Summary (FY93-94)

SPECIES	TAGGED		RECOVERED		TOTAL	
	FY93/FY94		FY93/FY94		Tagged /Recovered	
1. <i>Lethrinus harak</i>	228	367	1	4	595	5
2. <i>Lethrinus obsoletus</i>	541	476	16	6	1017	22
3. <i>Lethrinus atkinsoni</i>	13	131	0	0	144	0
4. <i>Lethrinus xanthochilis</i>	20	66	1	3	86	4
5. <i>Lethrinus olivaceus</i>	4	9	0	1	13	1
6. <i>Epinephelus merra</i>	503	266	1	0	769	1
7. <i>Epinephelus hexagonatus</i>	0	4	0	0	4	0
8. <i>Epinephelus polyphemus</i>	1	0	0	0	1	0
9. <i>Lutjanus fulvus</i>	19	10	0	0	29	0
10. <i>Lutjanus monostigmus</i>	10	6	0	0	16	0
11. <i>Lutjanus kasmira</i>	9	2	0	0	11	0
12. <i>Lutjanus argentimaculatus</i>	1	0	0	0	1	0
13. <i>Parupeneus barberinus</i>	3	2	0	0	5	0
14. <i>Parupeneus multifasciatus</i>	1	3	0	0	4	0
15. <i>Priacanthus hamrur</i>	0	1	0	0	1	0
16. <i>Chelinus undulatus</i>	0	1	0	0	1	0
17. <i>Chelinus trilobatus</i>	0	4	0	0	4	0
18. <i>Monotaxis grandoculus</i>	0	1	0	0	1	0
19. <i>Carangoides orthogrammus</i>	0	3	0	0	3	0
20. <i>Sphyrna barracuda</i>	0	1	0	0	1	0
21. <i>Novaculichthys taeniorus</i>	1	0	0	0	1	0
22. <i>Bodianus axillaris</i>	1	0	0	0	1	0
TOTAL	1,355	1,353	19	14	2,708	33

Of the 33 tag recoveries made thusfar, all have been made within a half-mile radius of where the fish was originally caught and tagged, and usually within three months from the time of tagging. Initial observations suggest that the tagged Lethrinids, especially with *L. obsoletus*, may have some temporal tendency to remain resident to specific sea-grass areas within Cocos Lagoon.

During FY94 another emperor, *Lethrinus atkinsoni*, was captured in surprisingly higher numbers than expected based on the previous year's catch. Whereas a total of 13 were captured in Cocos Lagoon in FY93, the number jumped to 131 in FY94. The increase in the catch rate began around November of 1993, peaked between January and March of 1994, and dropped off by May of the same year. It is suspected that an especially good recruitment of *L. atkinsoni* may have occurred sometime in FY93, or earlier, since most of those caught in FY94 were relatively small in size (about 150mm).

Habitat Loss

In April and May of 1994, especially good seasonal recruitments of two species of juvenile rabbitfishes, *Siganus spinus* and *Siganus argenteus*, were reported islandwide. Coincidentally, it was observed during the weekly tagging efforts that the seagrass beds (*Enhalus acoroides*) were gradually disappearing at the various tagging sites within Cocos Lagoon. By the end of June virtually all of the *E. acoroides* had disappeared. It is suspected that the herbivorous juvenile rabbitfish were responsible for the loss of the seagrass beds because a similar situation occurred in 1982 and again in 1988, where a bumper harvest of juvenile rabbitfish preceded a temporary disappearance of much of the seagrass in the lagoon. In both cases the seagrass eventually reestablished itself, but the extent and rate of recovery was never fully documented. The short-term effect of such a habitat loss for the Lethrinids that are being studied has yet to be determined. Although it is much more difficult to locate specific seagrass sites and sand halos, Lethrinids can still be caught in the general vicinity.

RECOMMENDATIONS

Of the 595 *L. harak* that have been tagged in the last two years, only 5 (<1%) have been recovered. For *L. obsoletus*, 22 out of 1,017 (>2%) have been recovered during the same period of time (>2%). Given the above, the FY93 recommendation to utilize *L. obsoletus* as a growth and population indicator species for Lethrinids in Cocos Lagoon will once again be made for FY95. Because of the continued low catch rate for *L. harak*, growth data may have to be derived from otolith studies, or sampling efforts modified to increase catch and tag recovery success (i.e., investigating other potential habitat sites).

This project will provide valuable information essential for the future management of Guam's stocks of *L. harak* and *L. obsoletus* and should be continued with the following recommendations for FY95:

1. Continue weekly tagging efforts but discontinue egg canulation procedure to minimize handling stress.
2. Concentrate the majority of the tagging effort at the beginning of FY95 then phase out completely towards the end of the fiscal year.
3. Consider the use of otolith studies to aid in determination of growth rates of *L. harak* and *L. obsoletus*.
4. Continue efforts to hire additional fisheries staff to facilitate regular tag and recovery efforts.
5. Begin laboratory examination of egg sample collection for average diameter, stage of development and size-frequency distribution relative to lunar cycle and month.
6. Reissue updated press releases of tagging program and continue distribution of posters to tackle shops, boat dealers, mayor's offices and appropriate government agencies.
7. Encourage public awareness and involvement with tagging and catch-and-release practices by providing reputable fishermen with tagging equipment and record-keeping material.
8. Complete project by end of FY95.

PROGRAM COSTS

The estimated costs of the Studies of Guam's Recreationally-Important Fish was \$73,986.00.

LITERATURE CITED

- Carpenter K.E., Allen G.R. 1989. FAO species catalogue. Vol. 9. Emperor Fishes and Large-Eye Breams of the World (Family Lethrinidae). FAO Fisheries Synopsis. No.125, Volume 9. Rome, FAO. pp 64, 77-78.
- Myers, R.F. 1991. Micronesian Reef Fishes. Coral Graphics, Guam. pp.143-147.
- Schroeder, R.E. 1980. Philippine Shore Fishes of the Western Sulu Sea. National Media Production Center, Manila, Philippines. pp.167.

Report prepared by: Andrew A. Torres

**JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT**

STATE: Territory of Guam

PROJECT NO.: F-1R-2
SUB-PROJECT NO.: F-2
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Development of Recreational Fishing in Fena Lake

PERIOD COVERED: October 1, 1993 to September 30, 1994.

SUMMARY

This project was inactive during FY94 due to a lack of staff.

OBJECTIVES

1. To determine species composition and status of stocks in Fena Lake. This information will be applied to the development of a management plan to implement recreational fishing in the lake.

RECOMMENDATION

The feasibility and needs for this project be reassessed due to recent changes in potential public access difficulties to the project area.

PROJECT COST:

The project cost for the Development of Recreational Fishing in Fena Lake was \$0.0.

Report prepared by Gerald W. Davis

JOB PROGRESS REPORT COORDINATION PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-1R-2
SUB-PROJECT NO.: F-3
JOB NO.: 1

JOB TITLE: Technical Guidance to Projects Affecting Guam's Fish Resources (2710,2720)

PERIOD COVERED: October 1, 1993 to September 30, 1994

BACKGROUND

The Division of Aquatic & Wildlife Resources' (DAWR) professional Fisheries Staff devoted a significant percentage of their time and effort to technical assistance. The rapid pace of development on the island is requiring increasing amounts of time from the Fishery Staff to fulfill its statutory responsibility to review and comment on development plans, rezoning applications, and various permit applications. Because of the size and complexity of some of these developments, the Fisheries Staff's review responsibility will require a continuing commitment that could extend even beyond project completion.

The Division's Technical Assistance Program (TAP) within the Administration/Coordination Section continues to handle the majority of the technical assistance. A local appropriation provides funding for two technical assistance staff members, a Biologist I and a Biologist II. These staff are primarily responsible for reviewing projects submitted to the Development Review Committee for action by the Territorial Land Use Commission and for the review of clearing and grading permit applications, but they also participate in the review of other permit applications and environmental documentation. The professional staff within the Fishery Section provide technical support to the TAP staff, and occasionally take the lead in the review of projects involving their particular expertise, such as those that may have endangered species (sea turtles) impacts and those involving coral reefs.

OBJECTIVES

1. To minimize adverse environmental impact resulting from the construction of recreational, commercial, residential, industrial or public utility facilities.
2. Provide technical assistance to military and civil agencies relative to the management and protection of fish resources.

FINDINGS

Fisheries Staff have been actively involved in the technical guidance function during this segment. Numerous development plans, impact statements, and permit applications have been submitted to the Division for review. Field investigations and meetings with responsible agencies have been conducted in many cases as a part of the review process.

Various Fisheries Staff members actively serve as members of the following groups:

1. Recreational Water Use Master Plan

2. Western Pacific Regional Pelagic Plan Monitoring Team
3. Western Pacific Regional Bottomfish Plan Monitoring Team
3. Western Pacific Regional Scientific and Statistical Committee
4. Guam Aquarium Council
5. Seashore Reserve Plan Task Force
6. Sea Grant Advisory Council
7. Oiled Wildlife Subcommittee of the Area Committee for Oil Spills.

Members of the Division have attended numerous meetings and hearings pertaining to the protection of Guam's natural resources and have actively consulted with various civil and military agencies on environmental matters. Division staff maintain close liaison with the Department of Land Management, Department of Parks and Recreation, Guam Bureau of Planning, Guam Environmental Protection Agency, University of Guam, U.S. Army Corps of Engineers (ACOE), U.S. Fish and Wildlife Service, Western Pacific Regional Fisheries Management Council, National Marine Fisheries Service, U.S. Navy, the U.S. Coast Guard, and U.S. Air Force regarding matters of environmental concern. In addition, staff members actively consulted with the numerous off-island visitors, representing various agencies and organizations, who visited during the segment.

Considerable public contact was maintained by Fisheries Staff during the reporting segment. In addition to occasional interviews on radio, television, and in the newspaper, they also gave talks to a number of civic groups, and school.

Some specific Technical Assistance activities provided by the Fisheries Section included:

1. Technical support to the Divisions TAP staff who represent the Department and the Division on the Development Review Committee, which met biweekly to review applications for rezoning, variances, and various types of development.
2. Participating with, and providing comments and assistance to, the Guam Environmental Protection Agency and the Office of the Attorney General in negotiations with Miyama Development Incorporated (MDI) regarding water rights issues .
3. Offering comments to and provided information to the Western Pacific Regional Fisheries Management Council (WESPAC) and the Plan Monitoring Team (PMT) on projects for bottom and pelagic fisheries. Information was provided on market sampling, and stock assessment, and from recreational and near-water commercial vessels.
4. Reviewing and commenting on several legislative bills that would affect fisheries.
5. Investigating several reports of suspected fish kills in island waters during the year.
6. Responding to many requests for information on laws and regulations pertaining to fish, endangered species, fishing and importation of fish.
7. Reviewing manuscripts for other authors and for professional journals.

8. Providing technical assistance to the Attorney General's Office in interpreting the laws and regulations that apply to fish resources. In addition, the Section requested for several legal opinions in regards to environmental issues.
9. Making several presentations on fish resources to other organizations or groups during the year.
10. Providing technical assistance to the Guam International Fishing Derby.
11. Meeting with numerous developers and their consultants and other government representatives to discuss their proposed development and its possible impacts on endangered species, wetlands and native habitat as well as erosion, project design, coral reefs, etc.
12. Providing input regarding candidate sites for conservation and marine reserves.
13. Providing statistical data on fisheries issues to the Bureau of Planning and Department of Commerce as supplemental information for local annual reports.
14. Providing additional review and comment on the revised proposal to construct an underwater observatory on the Piti reef flat
15. Participating in the review and submitting comments on mine exercises to be conducted by the U.S. Navy.
16. Provided staff for technical assistance by request to two off-island resource agencies. Provided one staff to assist the Commonwealth of the Northern Mariana Islands with a *Trochus* assessment for Saipan, Rota and Tinian. Also sent one staff to provide technical advice to the Republic of Belau to assist in the development of a coral reef oriented sportfishing industry.

PROGRAM COST

The estimated cost of the Technical Assistance project under F-1R-2 is \$32,233

RECOMMENDATIONS

This project needs to continue to support the TAP.

Report prepared by: Gerald W. Davis, Marvin Aguilar, Georgette Concepcion, and
Robert D. Anderson

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-2-D
SEGMENT: 6

PROJECT TITLE: Marine Fish Habitat Improvement and Aggregating Devices

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

Fish Aggregating Devices

Fish aggregating devices (FADs) continue to be popular among local offshore fishermen and requests for additional FAD sites have been incorporated in the Division of Aquatic & Wildlife Resource's (DAWR) FAD program expansion plans. Thusfar, seven sites have been approved by the appropriate Government of Guam agencies and authorized by the Army Corps of Engineers (ACOE). Three additional sites, Uruno Point, Ritidian Point and "Nine-mile", are expected to be approved and authorized in early-FY95. Four sites are currently operational: Adelup Point, Haputo Point, Facpi Point and Cocos Island. Figure 1 diagrams the approximate location of each of the ten FADs that will eventually make up the DAWR FAD program, and further designates the status of each site as either "operational", "permitted but not yet operational", or "new site to be permitted".

Two of the four operational FADs were lost in FY94: Adelup Point on April 19, and Haputo Point on May 22. The Adelup FAD was on station for almost 25 months while the Haputo FAD was on site for almost 26 months (both were deployed on March 27, 1992). The other two operational FADs, Facpi Point and Cocos Island, which were deployed on December 1, 1992, are still on station. Given the above, the average time on station of the DAWR FADs has been far exceeding the eight months reported in the FY92 annual report and appear to be approaching a much more acceptable lifespan of twenty-four months.

The Adelup and Haputo FADs were replaced on July 15 after a local tug company with a properly licensed vessel large enough to conduct buoy deployments was finally located by DAWR. The tug company was also contracted to pick up the buoy components at the Department of Agriculture facility and deliver the system for loading and assembly on the deployment vessel. Whereas the last two deployments in December 1992 were conducted at a total cost of \$9,000.00, not including delivery, the July 1994 pair of deployments, including delivery, were done at a cost of \$2,664.16 - a savings of \$6,335.84.

DAWR efforts in FY95 will continue to concentrate on preparations to activate all the proposed FAD sites while maintaining an adequate inventory of backup systems to serve as immediate replacements for any lost systems. Concern about the rising costs of constructing and maintaining FAD systems has prompted DAWR to investigate possible alternatives in FAD system design and maintenance strategies. Several cost-cutting possibilities include the use of a lighter, more durable buoy design and the purchase of buoy lights with a longer battery life.

Shallow Water Moorings

No activity was recorded in FY94 for the shallow water mooring project.

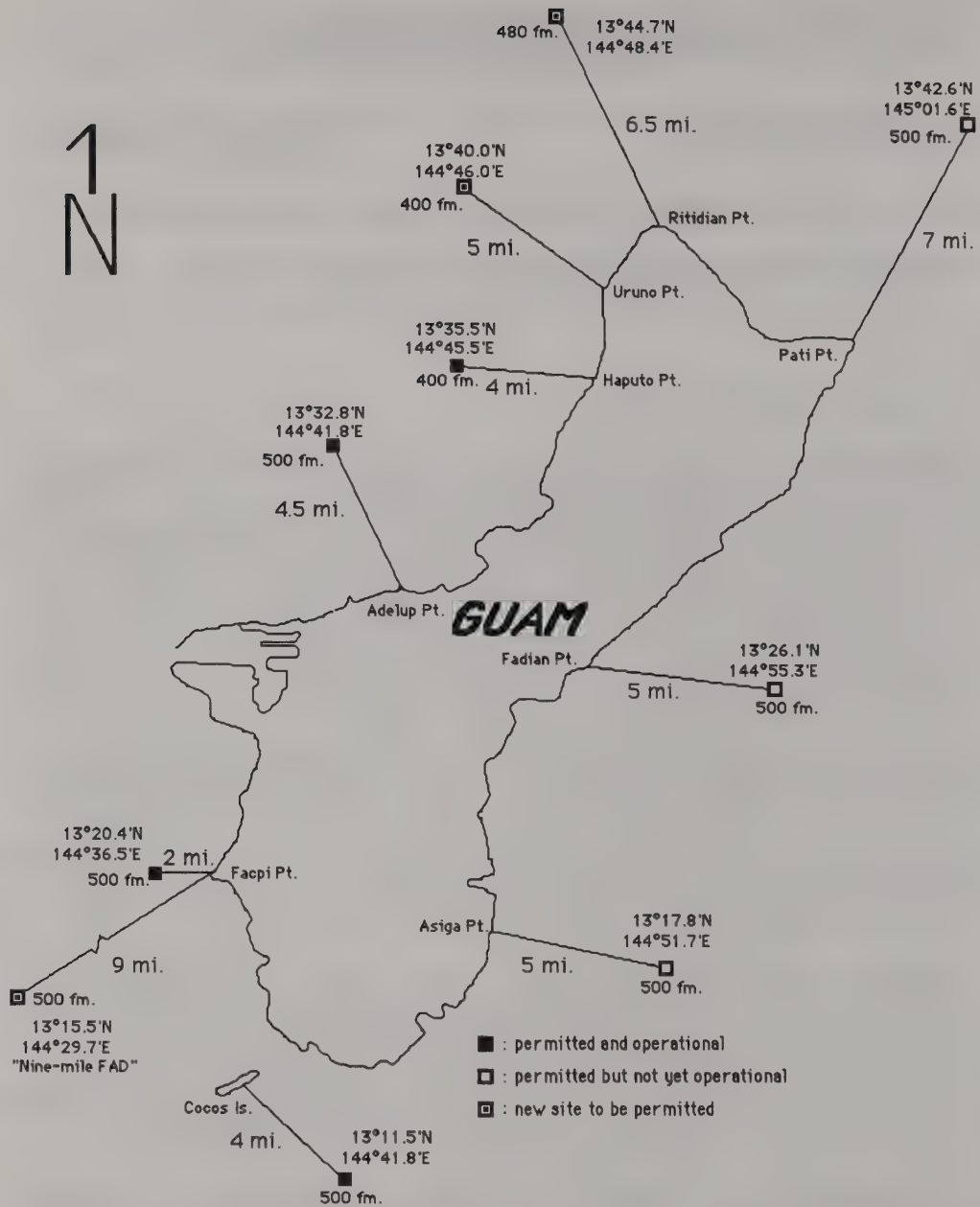


Figure 1. FAD sites

Fish Aggregating Devices

BACKGROUND

Guam's most productive trolling occurs in the vicinity of offshore banks such as White Tuna Bank, Santa Rosa Reef, Galvez Bank, Eleven-mile Bank and Rota Bank. However, because of their distances from the Island's marinas and boat launches, these fishing areas are not always safely accessible for many boats, especially during inclement weather. Furthermore, the amount of fuel consumed to reach the popular fishing banks usually makes the fishing trip an expensive outing.

Fish aggregating devices are effective in attracting and holding pelagic migratory fishes such as yellowfin (*Thunnus albacares*) and bonita (*Katsuwonus pelamis*) tuna, kawakawa (*Euthynnus affinis*), wahoo (*Acanthocybium solandri*), mahi mahi (*Coryphaena hippurus*) and blue marlin (*Makaira nigricans*), in offshore coastal waters (Kanenaka & Higashi, 1989). Although the FADs will increase the harvest of Pacific migratory fishes in Guam's waters, the additional pressure will have no significant impact on the fish stocks because the harvest will remain small-scale and only represent an extremely small percentage of the total amount of migratory fish that pass through Guam's offshore waters.

FADs have no adverse impact on non-migratory pelagic or demersal fish, fauna, wildlife and other natural environmental values, and conform to United States Coast Guard requirements for marking, lighting and standardization of aids to navigation.

Installation of FADs in Guam's offshore coastal waters began in 1979, initially with funding from the Saltonstall-Kennedy Act through the Pacific Tuna Development Foundation. The Guam FAD project is currently being continued as part of Dingle-Johnson/Wallop-Breaux Sport Fish Restoration program.

OBJECTIVE

DAWR's objective is to develop, deploy and maintain fish aggregating devices and shallow water moorings in the nearshore waters off Guam.

PROCEDURES

Construction and Deployment

Procedures for construction and deployment of the Adelup and Haputo FADs during FY94 followed the established methods recorded in the FY91 and FY92 annual reports. Recent modifications to the design and construction of the buoy systems include the addition of reflective tape to the buoy light post, installation of a radar reflector, attachment of identification labels, and the use of a single 1³/₄-ton anchor block instead of two ³/₄-ton anchors. The radar reflector and amber buoy light are installed after the system has been deployed to avoid damage or loss during the deployment procedure.

FAD Inspection and Maintenance

FAD inspection and maintenance are conducted on a biweekly basis as sea conditions and available manpower permit. The DAWR FAD program service vessel (19'6" Enterprise "Corwin") launches from the Agana Boat Basin for trips to the northern buoys - Adelup Point and Haputo Point, and then on the following week, from either the Agat Marina or Merizo Pier for trips to the southern buoys - Facpi Point and Cocos Island.

The maintenance routine of a FAD includes occasional underwater inspection of shackle wear at the buoy/chain junction and a check on the condition of the navigational light. A voltage meter is used to measure the battery charge during each light inspection. If the voltage reading falls between 3.0 and 4.0 volts, the light is replaced because the McDermott system currently in use yields a very dim flash below 4.0 volts, and ceases to flash altogether below 3.0 volts (based on the use of 6-volt super-heavy duty carbon lantern batteries). Also included in the maintenance procedure is an inspection for burned-out light bulbs, a defective photocell or a malfunctioning light mechanism.

RESULTS

Renewal of FAD Project Permit

On October 16, 1992, the Division of Aquatic and Wildlife Resources was issued Nationwide Permit 4 No. GNW 93-002 by the Army Corps of Engineers to replace General Permit No. PODCO-O GP 82-3 which expired on April 14, 1992. The Nationwide Permit 4 (Fish Harvesting Devices) authorizes DAWR to continue the installation and maintenance of FADs at designated sites in the offshore coastal waters around Guam, but is valid for only a two-year period instead of the ten years previously granted under the General Permit. In spite of its comparatively short duration of two years however, the Nationwide Permit 4 can be modified and renewed expeditiously since authorization is granted through the local ACOE regional office on Guam. Due to ACOE permit application revisions, DAWR FAD project permit requests must be processed under ACOE's Nationwide Permit authority since the General Permit category will no longer apply. The current FAD project permit is due to expire on October 16, 1994 and a request to renew for another two-year period was submitted at the end of FY94.

Prior to the issuance of GNW 93-002 in FY93, DAWR complied with ACOE's request to forward FAD program concurrence by the Government of Guam's Bureau of Planning (BOP) for Coastal Zone Management (CZM) program consistency, Environmental Protection Agency for 401 Water Quality certification, and clearance from the Department of Parks and Recreation's Historic Resources Division. ACOE has informed DAWR that the renewal of the Nationwide Permit for FY95 - FY96, which includes the three new proposed sites, will only need the reissuance of a CZM consistency statement from the Bureau of Planning. A request for such a compliance statement was sent to BOP at the end of FY94.

New Sites

As recommended in the FY93 annual report, DAWR has requested ACOE to modify the current Nationwide Permit to include three additional FAD sites: "Uruno Point", "Ritidian Point" and "Nine-Mile". Each of the three new sites are designated in Figure 1 as "new site to be permitted". To date, four FADs remain operational and six more are scheduled to be deployed by FY95, which would bring the DAWR FAD program up to a total of ten systems.

Fishing Surveys

In early FY93 and on several occasions in FY94, fishing surveys of FADs were conducted as part of an in-house effort to collect data on the effectiveness of each FAD, but were later temporarily discontinued due to a shortage of available man-hours. Fish caught during the survey were identified, measured, recorded, and then released. Several fish were tagged to determine the feasibility of such a procedure for FAD studies in the future. The relative success of the fishing effort during several of the FY93 in-house surveys resulted in

occasional mortalities, which later raised the concern as to the disposition of this catch. DAWR protocol for such "takes" is to donate the catch to a local rest home and has since been implemented. Compilation of the data collected from earlier DAWR in-house FAD surveys was not expanded due to inconsistent and insufficient data collection.

Other FAD fishing information, usually collected via the offshore creel surveys, were also discontinued in FY93 because the data is now viewed by DAWR as unreliable. One of the major inconsistencies of the offshore creel survey concerns the distinction between when a boat is fishing, or not fishing, a FAD (i.e., upon visual contact, within 100 yards, 1 mile, 2 miles, 4 miles, etc.).

Manpower

DAWR is continuing efforts to acquire additional staff to assist with the FAD program by creating new openings and filling vacancies within the Fisheries Section. DAWR's efforts in FY93 and FY94 to acquire additional staff to assist part-time resulted in the hiring of two Technician I's and a Biologist I. However, the departure of the senior technician in February, 1994, to attend a six-month training program off-island and the termination in April of another technician, had the net effect of reducing the actual amount of man-hours committed to the FAD project to a level less than that of the previous year. Consequently, manpower for the FAD project was primarily directed at continuing maintenance procedures of the operational FADs.

FAD Equipment Inventory

The last shipment of FAD mooring equipment, enough for ten 500-fathom systems, was received at the beginning of FY93. Included in the shipment were nylon and polypropylene line, chain, shackles and thimbles; essentially all the basic components of a FAD mooring system. Two of the above mooring systems were utilized for the December 1992 FAD redeployments at Facpi Point and Cocos Island, and another two systems were used for the July 1994 redeployments at Adelup Point and Haputo Point; thus leaving six 500-fathom systems available for expeditious replacement of lost FADs or new site deployments. Because DAWR intends to bring the number of operational fishing buoys in its FAD program up to ten systems by the end of FY95, additional equipment will be have to be procured to accommodate future new-site deployments (6 systems) as well as old-site replacements (10 systems).

The last two sets of $\frac{3}{4}$ -ton pyramid-shaped anchor blocks were used for the above December 1992 deployments. The use of two anchor blocks instead of one, came from concern that a single $\frac{3}{4}$ -ton anchor was insufficient weight to hold the buoy system in place. However, there is now considerable concern that the descent pattern of a two-block system may result in one crashing into the other upon landing, possibly damaging one block or both in the process. For this reason, twenty pyramid-shaped $1\frac{3}{4}$ -ton anchor blocks were acquired in June, 1993, to facilitate a return to a single large anchor block system instead of using two smaller ones.

The last two buoys in the DAWR inventory were reconditioned and eventually utilized in July 1994 to replace the lost Adelup and Haputo FADs. Efforts are currently underway to restock DAWR's inventory of buoys and mooring system components by mid-FY95.

FAD Losses

There were two FAD losses in FY94: Adelup Point on April 19, 1994, and Haputo Point on May 22, 1994; both of which were reported by charter boats who regularly work in the vicinity of the buoys. The cause of each buoy loss could not be determined because neither buoy was recovered. The Adelup Point and Haputo Point FADs were deployed on March 27, 1992 and had far exceeded the previous average time on station of 8 months by 17 and 18 months respectively.

It is noteworthy to mention that the other two operational FADs, Cocos Island and Facpi Point, which were deployed on December 1, 1992, have thusfar been on station for 21 months. Given this, there is a high likelihood that the Cocos and Haputo FADs may fail sometime within FY95.

FAD Deployments

Two deployments were made on July 15, 1994: one to replace the lost Adelup Point FAD, and the other to replace the missing Haputo Point FAD. For these deployments, DAWR was especially fortunate in locating a local tug company that operated a properly licensed vessel large enough to conduct multiple FAD deployments at a very reasonable price. Whereas, the previous vessel, which has since permanently departed Guam, was contracted to conduct FAD deployments at a set price of \$4,500.00 per FAD, the current vessel hired to conduct the most recent set of deployments did so at a cost of \$1,332.08 per FAD - a savings of \$3,167.92 per deployment. Furthermore, the latter company's price included the transport of FAD components from the Department of Agriculture facility down to the port as well as the loading, assembling and securing of the FAD system onto the deployment vessel.

Buoy Modifications

In order to comply with U.S. Coast Guard requirements, and to protect the FADs from collisions with larger vessels, radar reflectors (Davis "Echomaster" Standard #152) were purchased and modified for installation on DAWR FADs. The installation of radar reflectors began with the Facpi Point and Cocos Island FADs on September 3, 1993 (buoys deployed 12/1/92), and later installed on the Adelup Point and Haputo Point FADs on September 15, 1993 (buoys deployed 3/27/92). Radar reflectors will be routinely installed immediately after buoy deployments as was the case with the July 15, 1994 deployments of the Adelup and Haputo FADs.

In addition to the installation of the radar reflectors, two bands of two-inch wide reflective tape were placed on each of the FAD light posts prior to deployment as a further precautionary measure.

As recommended in the FY92 annual report, attachment of counterweights to the currently operational buoys would greatly reduce the amount of sway and help to keep the buoy more up right. However, the initial plan of adding more chain or any other form of weight to the buoy/mooring assembly was abandoned because of DAWR vessel and equipment limitations. The proposed operation would have been of more costly and dangerous than it was worth. To avoid this problem in the future, the specifications for the twenty buoys DAWR hopes to acquire in FY95 will include the installation of counterweights.

FAD System Cost Analysis

The FY93 and FY94 cost comparison per FAD system and deployment, excluding maintenance and surveys, is listed in Table 1 below. The single most significant reduction in the two years is in the cost of deployment where a \$3,167.92 per FAD savings was realized with the selection of a new vendor to conduct FAD deployments.

Table 1. FAD System Cost Analysis FY93 - FY94

ITEM	UNIT COST	
	FY93	FY94
Buoy	\$ 500.00*	\$ 500.00*
Anchor Block	\$1,142.86*	\$1,025.00
Mooring System	\$5,186.16	\$5,186.16
Buoy Light	\$ 171.29*	\$ 171.29*
Deployment	\$4,500.00	\$1,332.08
TOTAL COST/FAD	\$11,500.31	\$8,214.53

*from R. Hensley, 1990

RECOMMENDATIONS

Fish Aggregating Devices

FADs remain quite popular with local fishermen and are most noticed when the systems are no longer on site. The project should be continued with the following recommendations:

1. Acquire inventory of new-site and back-up FAD buoys (20-30); complete all buoy modifications and markings before deployments.
2. Reorder equipment and supplies for FAD mooring systems to maintain an inventory of replacement systems.
3. Consider alternative buoy system designs for eastern windward sites, which will be less accessible and subjected to rougher sea conditions for longer periods of time.
4. Conduct bottom contour surveys of Uruno Point, Ritidian Point and "Nine-mile" FAD sites in preparation for deployments.
5. Continue deployment of FADs at remaining six sites.
6. Continue contracting of current vendor to conduct FAD deployments; conduct multiple deployments when possible since vessel is hired on an hourly basis.
7. Purchase a larger, more reliable commercial-duty vessel capable of FAD maintenance and deployment including necessary electronics and hardware;
8. Allocate additional manpower to help deploy, maintain and survey FADs.
9. Design more appropriate FAD survey method.

10. Improve longevity of buoy light operation by using better battery systems; investigate use of other navigational lighting systems that are more economical, reliable and long-lived than the present systems.
11. Attach strips of strapping tape to buoy chain to provide additional baitfish habitat thereby enhancing the overall productivity of each FAD.
12. Attach painters to FADs to facilitate safe and convenient servicing of buoys as well as to provide recreational boats with a safe means to tie on to the buoys.

Shallow Water Moorings

The popularity of water-related activities has resulted in an increase in damage to coral reefs near popular sites caused by the setting of anchors. The installation of mooring buoys is one way of reducing such damage. However, due to a continued shortage of manpower in the Fisheries Section and the amount of time that has lapsed since the need for mooring buoys was originally identified, DAWR recommends that the project be sub-contracted out to prevent any further delays in the deployment of the shallow water mooring buoy systems.

PROJECT TIME LINE

Fish Aggregating Devices

	FY 1995											
	<u>Oct</u>	<u>Nov</u>	<u>Dec</u>	<u>Jan</u>	<u>Feb</u>	<u>Mar</u>	<u>Apr</u>	<u>May</u>	<u>Jun</u>	<u>Jul</u>	<u>Aug</u>	<u>Sept</u>
Bottom contour surveys of new sites	X											
Acquisition of FAD buoys		X	X	X	X							
Purchase mooring systems			X	X	X	X						
Assembly & deployment of FADs									X	X	X	X
Purchase vessel & towing vehicle		X	X	X	X	X						
Attach strapping strips to buoy chains		X			X		X		X		X	X
Purchase and attach painters to FADs				X		X		X		X		X

PROGRAM COSTS

Fish Aggregating Devices

The estimated cost for the FAD project for FY94 is \$78,000.

Shallow Water Moorings

The estimated cost for the Shallow Water Mooring project is \$0.

LITERATURE CITED

- Hensley, R. 1990. Construction of Fish Aggregation Devices and Development of Shallow Water Mooring System. Annual Report Fiscal Year 1990, Division of Aquatic and Wildlife Resources, Department of Agriculture, Government of Guam.
- Kanenaka, B. & Higashi, G. 1989. Artificial Fish Shelter/Fish Aggregating System Development and Operation. Job Progress Report 1989, Hawaii Division of Aquatic Resources.

Prepared by: Andrew A. Torres

JOB PROJECT REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO: F-2-D
SEGMENT: 7

JOB TITLE: Development of Small Boat Launching Facilities (2332)

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

Planning for the Merizo Pier project began during FY88. A groundbreaking ceremony for the actual construction was held on April 30, 1991 and construction was completed on July 24, 1992. The official dedication ceremony was held on October 4, 1993 at the Merizo Pier. The pier was constructed by the International Bridge Corporation at a cost of \$369,700. The Department of Public Works was designated as the contract administrator for the project.

The Merizo pier has been used extensively by the public since its completion. Use of the pier, along with corrosion due to saltwater, has made it necessary to do periodic maintenance.

Projects in the planning phase include the enhancement of present boat ramps and construction of additional small boat ramps. The proposed boat ramps are located on the eastern side of Guam to provide access to recreational and fishing resources on the eastern side of Guam.

Plans to construct small boat ramps on the eastern side of Guam have been ongoing. These boat ramps would provide access to fishing grounds and provide a safe port for boats during emergencies. Recently, boaters have been observed regularly launching off the southern bank of Ylig River. Vehicle-trailers have been observed parking adjacent to Ylig Bridge in the small clearing and even across Route 4. This reinforces the need for small boat launching facilities on the eastern side of Guam.

OBJECTIVES

Redesign and renovate the existing public boat-launching ramp located in Merizo and develop plans for new boat ramps at two sites on the eastern side of the island.

RESULTS

The official dedication ceremony for the Merizo Pier was held on October 4, 1994 at the Merizo Pier. Dignitaries in attendance include members of the Merizo Planning Council, Merizo Mayor Ignacio "Buck" Cruz, Department of Agriculture's Director Antonio Quitugua, and Lieutenant Governor Frank Blas.

The Merizo Pier has been periodically monitored for wear and tear. Items currently missing from the pier include clips on the grates, which make up the handicap access ramp, stainless steel bolts on the lampposts, lag screws on the pier, and several dock cleats. The dock cleats should be replaced with larger cleats since the present cleats are too small to handle boats docking at the pier. The ladders on the pier have signs of corrosion, especially areas where bolts join sections of the ladder together and where the ladders are

bolted to the pier. Replacement stainless steel lag screws, galvanized lag screws and twelve-inch galvanized dock cleats are being ordered to replace the present dock cleats and missing lag screws. A work order to repair the corroded ladders has been proposed and is pending final approval.

The construction of the Ylig small boat ramp is being pursued. Presently, small boat operators are using the southern bank of Ylig River as a launch site depending on the tide, weather conditions, and available parking. A listing of lot ownership along the Ylig River has been completed. A design for a single boat ramp with parking facilities is available from previous boat ramp projects. This design may be used or modified to meet the needs of specific boat ramp sites.

Plans for the construction of a boat ramp at Inarajan have been initiated. The Guam Power Authority will be funding the construction of the boat ramp as mitigation for development of an intake channel for the Cabras power plant. The Department of Public Works has been designated as the contract administrator, and W.B. Flores & Associates has been contracted to complete the design of the ramp facility and permitting process. Federal Aid funds will be used to gather information and write the Environmental Impact Assessment as well as project monitoring to be done by DAWR.

RECOMMENDATIONS

The construction of additional small boat ramps on the eastern side of Guam and the repair and enhancement of the existing small boat ramps should be further pursued. Potential boat ramp sites are being evaluated for land ownership, boating accessibility, traffic safety, exposure to wave action and sediment deposition, and other factors. Boat ramps located along major highways need to consider future highway expansion projects by the Department of Public Works. The existing small boat ramps should be evaluated for enhancement and repair projects to improve the current facilities. This includes repairing holes and cracks on the ramps, repairing the worn-out grooves on the ramps which provide traction for vehicles launching boats, providing additional lighting, adding cleats along the ramps to enable single boaters to tie to while parking their vehicle, repairing and constructing additional parking facilities, and maintaining and adding channel markers or buoys to improve navigation.

GOAL FOR FY95

The Ylig boat ramp site and the Merizo boat launch facility have both been identified as valuable boating access areas, which need improvement. During FY95, effort to complete design work through a bid contract will be performed in the first six months. Upon satisfactory completion, the bid for construction will be initiated.

Assessments for the construction of additional boating ramp sites and for the repair and enhancement of other existing boat ramps should be continued. The data acquired should be organized to begin initiating these projects.

PROJECT COST

The cost of the project this fiscal year is approximately \$42,250.

Report Prepared by: Thomas Flores, Jr.

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D
SEGMENT: 2

JOB TITLE: Development of Inshore Fishing Access Facilities (2331)

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

During the FY94, the necessary documents to fulfill permit applications for constructing fishing platforms were prepared for environmental review by both local and federal government agencies. Several sites were also added because of coral concerns in other areas. After the governmental review is complete, we will put the project out on bid to construct the fishing platforms.

BACKGROUND

The historical, traditional use and design of fishing platforms has been reviewed in previous fiscal year reports (Kruckenberg, 1989-1993). Because inshore fishing continues to be a popular activity, there is a real need to provide greater accessibility to inshore fishing areas and improved safety in areas that are typically unsafe.

OBJECTIVES

To plan, design and construct inshore fishing access facilities (reef flat platforms and cliff platforms) on the windward coast of Guam and research the possibilities of alternate sites on the leeward coast.

PROCEDURES

The Division of Aquatic and Wildlife Resources (DAWR) has been actively pursuing the planning, design, site selection, environmental review and construction of the reef flat fishing platforms. The primary focus during FY94 was to prepare the documents necessary for environmental review by the governmental agencies.

RESULTS

The Environmental Impact Assessment and the documents necessary for territorial and federal governmental review have been completed. Nine areas with a total of fourteen sites have been selected for fishing platforms: Pago Bay (1), Ylig Bay (2), Togcha Bay (2), Talofofo Bay (1), Agfayan Bay (2), Ajayan Bay (1), Togcha Beach (1), Tepungan Channel (2) and Asan Bay (2). After the governmental review has been completed, the project will be put out on bid to have the fishing platforms constructed at the approved sites.

DISCUSSION

During the fiscal year, one of the initial areas to receive fishing platforms had to be abandoned and another area had two new sites added because coral became established at the original site. One site located in a traditional fishing spot was abandoned to create two new sites to increase access. Five areas have been slotted to receive two platforms because of their popularity and/or potential as fishing spots. By having fourteen sites, we wanted to insure that enough potential sites were available for the project incase some of the sites were disapproved during the review process.

RECOMMENDATIONS

This program has valuable fishing application for Guam while providing a safety factor and enhancing fishing opportunities. We therefore recommend that this job continue to develop a fishing platform program on Guam.

PROGRAM COSTS

The estimated cost of the project was \$15,000.

Report prepared by: Wayne Kruckenberg

JOB PROGRESS REPORT DEVELOPMENT PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: F-2-D
SEGMENT: 10

JOB TITLE: Masso Reservoir Restoration (2322)

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

A conceptual general design has been formulated for the Masso Reservoir Project. The design has considered past concepts and future goals. The complete project will be put out to bid including all design, permitting, and construction costs during FY95.

BACKGROUND

The project will enhance sport fishing opportunities and protect the freshwater finfish resources at Masso Reservoir. The past concepts and brief history of the reservoir were outlined in last years job progress report (Kruckenberg, 1993). The project involves the dredging of the reservoir, constructing sediment basins in the Masso Valley watersheds, rehabilitation of the water control gate structure, the development of the area for public access and the reservoir shoreline for fishing.

OBJECTIVES

1. To conduct an assessment of fauna, habitat and facilities on the old Masso Reservoir project site.
2. To utilize the assessment information and review the original project plan to develop a scope of work to restore the Masso Reservoir Project.

RESULTS

During FY94, a general conceptual general design has been formulated for the Masso Reservoir Restoration Project. This concept was the result of information gathered on site-specific development concerns and review of potential methods which will minimize or eliminate negative environmental impacts. During FY94, the decision to contract the entire scope of work was made. The basis for this decision was staff limitations and to help ensure that no federal aid funds are reverted. Early in FY95, a bid package will be submitted to contract (1) design work, (2) environmental review and permitting and (3) construction.

RECOMMENDATIONS

This program has valuable freshwater fishing application for Guam while providing a safety factor and enhancing fishing opportunities. We therefore recommend that this job continue to develop a freshwater reservoir on Guam for sport fishing.

PROGRAM COSTS

It is estimated to cost of \$900 to restore the Masso Reservoir.

Report prepared by: Wayne Kruckenberg

GUAM COMMERCIAL FISHERIES

STATE: Territory of Guam

JOB TITLE: Commercial Fisheries on Guam

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

Commercial landings of locally caught fish are an important component of our total fisheries catch. The troll (pelagic) caught fish continue to make up the majority of the total fish landed by weight. Reef fish, bottom fish, imported fish, other fish and invertebrates made up a smaller portion of the catch. The data for this fiscal year has been sent to NMFS in Hawaii for processing. The summary data is available from NMFS or our office.

BACKGROUND

The Commercial Fisheries Program was established to monitor the fishery resource being caught and sold on Guam. In the past, the National Marine Fisheries Service (NMFS) has been collecting data only from the Guam Fishermen's Cooperative in Agana. Because it's been difficult for NMFS to handle the logistics of the program indirectly from Hawaii, the Division of Aquatic and Wildlife Resources has assisted directly with the program since January, 1990.

OBJECTIVES

To monitor, analyze and report on locally caught fish sales and related activities through the collection of vendor receipts

PROCEDURES

There are two cooperating vendors presently providing receipt data to the program. The Guam Commercial Fisheries receipt books are provided to each vendor in the program. Each receipt asks for information to be completed by each cooperating vendor while the catch is being purchased. On each receipt, there is a space provided for the name of the person providing the catch, fisherman number, date, number of fishermen, hours fished, fishing location and fishing method. The fishing location number and fishing methods code are determined by using the chart included on the inside of each receipt book cover. The catch information is broken down into six primary areas: (1) Bottom fish, (2) Reef fish, (3) Troll (pelagic) fish, (4) Invertebrates, (5) Seaweeds, and (6) Imported Items. Each item has a code number to identify the fish, invertebrate, or seaweed. Space is provided to indicate the number of items, total weight, price paid per pound, the value of the items, the total value of the transaction and any additional remarks about the transaction. There are three copies of each receipt with one for the person representing the catch, one for the vendor, and one for processing the information into the computer data base.

The vendors were visited on a regular basis to monitor the completion of the forms, collect completed receipt books, check data completion and insure that they had a supply of receipt books. A log book was used to record when a receipt book was initially given and received back from a vendor. When a receipt book was returned, the name of the vendor was indicated on the outside at the top to indicate which vendor completed the receipt book. The receipt books were transmitted to the NMFS office at Hawaii for data processing and sent back.

RESULTS

During FY94, 64 receipt books were collected from the cooperating vendors and processed at Hawaii. Summary data was sent back to us with monthly and year end totals. The data is presented in the "Fishery Statistics of the Western Pacific" and the bottom fish and pelagic plan monitoring team annual reports.

DISCUSSION

Since the initiation of the commercial fisheries program, our responsibilities have slowly increased. We have continued to spend a considerable amount of time performing quality control on the fisheries data. Each receipt was coded with a number according to who made the transaction with the vendor. We have been responsible for tracking the receipts before a code number is assigned and the assigning of code numbers to people selling fish to the vendors. During the receipt book review, we either code and/or double check the code numbers for the vendor that codes their own receipts. During the year, it became established methodology to double check all assigned code numbers to check for any possible errors made during the process. In addition, we have continued to check for mistakes in the calculations on each receipt and follow up with the vendors to get the correct data. This helped insure that correct data was keypunched into the computers at Hawaii.

Our initial intent was to analyze the summary data received from Hawaii. Because the quality control of the data takes up most of our available time at the office, further analysis of the data locally has been put on indefinite hold. The summary data can be obtained in the "Fishery Statistics of the Western Pacific" published annually by the National Marine Fisheries Service in Honolulu, Hawaii or by contacting our office.

At this time, the cooperators with the commercial fisheries program are voluntary. Based on our observations of commercial sales, we have had a decrease to 60% in our estimated total coverage of the locally caught fish. This has been because commercial fishermen have been selling more of their catch along the roadside. In addition, we are not covering imported frozen fish and the many roadside vendors importing fish from the Philippines and/or Micronesia. The primary goal of the program is to gather as much information as we can about our fisheries resource and have the collected data represent a complete picture of the locally caught and sold fish.

RECOMMENDATIONS

1. To determine the computer needs and establish an computer program for the commercial fisheries data collected on Guam. This would allow the data to be analyzed locally instead of being shipped off-island to be processed.
2. A law or regulation be passed that would require that people use an identification number in selling their catch to vendors and for vendors of local fish products to use our commercial fisheries receipts in their business transactions. This would give a more comprehensive view of the commercial fisheries activity around Guam. If such a law or regulation is passed, the person working directly with new vendors should be accompanied by a Conservation Officer until they use the receipts on a regular basis with no hesitation and/or resistance.

Report prepared by: Wayne Kruckenberg

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-2
SUB-PROJECT NO.: W-1
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Determination of Current Population Size and Distribution of Guam Deer (1460)

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

Population trend data obtained from spotlight counts on Andersen Air Force Base (AAFB) and Naval Magazine indicated no significant changes ($p > 0.05$) in deer (*Cervus mariannus*) numbers. Hunting license sales decreased 8.5% in FY94, with 750 sold during the year. Counts of the abundance of wild (feral) Asiatic water buffalo (*Bubalus bubalis*) made during deer counts on Naval Magazine showed a significant increase during FY94.

BACKGROUND

The Guam deer has been under investigation by the Division of Aquatic & Wildlife Resources since 1961. Its distribution, population trends and biology have been described by Wheeler (1979). Deer hunting statistics have been compiled since 1968 through hunter reporting procedures. The regular deer season is October 1 through December 31 with a bag limit of one antlered deer per season per license holder exclusive of any special hunt harvest. The Director of Agriculture can authorize a special either-sex hunt to thin a particular herd in situations where the population presents a threat to life or property and to prevent damage to other natural resources from overgrazing.

OBJECTIVES

To determine the current size and distribution of the deer population of Guam and to monitor population trends.

PROCEDURES

1. Continue spotlight counts on AAFB at 21 counts per year, 4 per month in May - July and one per month in other months.
 - a. Record number, age, sex and group composition.
 - b. Statistically analyze count data and compare with past data to discern population trends.
2. Continue monthly spotlight counts on Naval Magazine with periodic spotlight counts in other areas.
3. Collect hunting statistics via a hunter questionnaire. Analyze hunting statistics for changes in hunter kill, effort, and hunting location.
4. Collect biological data from carcasses killed during regular season and special hunts or from incidental sources such as road kills or confiscated animals.
5. Record water buffalo numbers incidentally to deer survey.

RESULTS

Deer Hunting Statistics

Total hunting license sales decreased 8.5% during FY94, with 750 sold during the year. Hunt data were compiled for last year (FY93) by mailing out 819 hunter questionnaires this fiscal year. Based on 140 responses, an estimated 638 people hunted all species of game during the FY93 season (Table 1). An estimated 416 deer hunters, spent 4,680 days to harvest 129 deer, or an estimated 36 days expended per deer taken.

Table 1. Summary of island-wide deer hunting statistics for FY93 derived from hunter questionnaires mailed out in FY94.

a. Total license sales for all game species.	819
b. Number of questionnaires sent out.	819
c. Number of questionnaires returned.	140
d. Percent queried license buyers that responded.	17.1%
e. Number of reporting license buyers that hunted any species.	109
f. Percent of license buyers that hunted any species.	77.9%
g. Estimated total number of legal hunters.	638
h. Number of reporting hunters that hunted deer during the regular season.	71
i. Percent of reporting hunters (109) that hunted deer during the regular season.	65%
j. Number of deer taken by deer hunters.	22
k. Hunter success.	31%
l. Hunter-days expended by reporting deer hunters.	808
m. Average number of days spent per reporting deer hunter.	11
n. Estimated total number of legal deer hunters.	415
o. Estimated total deer take.	129
p. Estimated total number of days spent hunting deer.	4680
q. Number of days spent hunting per deer taken.	36

According to hunter logs from AAFB, 1560 hunter-days (3264 sorties) were expended at Northwest Field and resulted in the harvest of 81 deer (Table 2). Bow areas on the main base recorded 545.4 hunter-days (1498 hunter-sorties), with five deer killed. The Conventional Weapons Storage Area recorded 420.6 hunter-days (917 sorties) and resulted in the harvest of 45 deer.

Table 2. Hunter effort and deer take based on official hunter logs from Northwest Field, bow areas on the main base, and the Conventional Weapons Storage Area (CWSA) on Andersen Air Force Base, FY94.

Andersen Air Force Base

	Oct	Nov	Dec	Sep	Total
Northwest Field					
No. Hunter Sorties	723	236	546	573	2078
No. hunter days (8-hr.)	360	102.5	242.3	298.1	1002.9
Deer taken	14	9	14	15	52
Days effort/take	25.7	11.4	17.3	19.9	19.3
Bow Areas					
No. Hunter Sorties	126	47	125	215	513
No. hunter days (8-hr.)	46.7	28.4	40.6	97.5	213.2
No. Deer taken	1	0	0	4	5
Days effort/take	46.7	-	-	24.4	42.6

CWSA					
No. Hunter Sorties	130	24	100	100	354
No. hunter days (8-hr.)	67.8	11.6	35.4	54.1	168.9
No. Deer taken	0	0	0	0	0
Days effort/take	-	-	-	-	-

Two special hunts in January and February 1994 resulted in the take of 55 deer (30 in January 25 in February). Licenses sold for these hunts totaled 60 shotgun licenses for each month and 42 and 40 bow licenses for January and February, respectively.

Records of hunting activity and harvest are not available this year for Naval Computer and Telecommunications Area Master Station.

Spotlight Count Trends

Deer numbers observed on Naval Magazine during FY94 were not significantly different from FY93 (Mann Whitney U-Test, $U' = 86.5$, $n_1=12$, $n_2=12$, $p>0.05$). The average number of deer seen per count decreased from 71.4 deer in FY93 to 60.2 in FY94 (Table 3). The largest single nightly count decreased from 98 deer in FY93 to 92 deer in FY94.

Table 3. Composition of deer herd during spotlight counts at Naval Magazine, Guam, FY94.

	1993 1994												Total	Mean	SD
	OCT	NOV	DEC	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP			
Unclassed buck	0	3	5	0	1	6	1	2	2	1	1	3	25	2.1	1.9
Spike	1	5	5	8	3	2	3	1	1	4	2	1	36	3	2.2
2pt	0	2	1	0	3	1	2	1	2	1	1	0	14	1.2	0.9
3pt	2	0	3	1	6	0	1	0	1	2	2	0	18	1.5	1.7
4pt	0	0	0	0	1	3	1	0	0	0	0	1	6	0.5	0.9
Doe	18	43	44	19	21	31	17	30	27	30	14	34	328	27.3	9.9
Yearling	3	11	9	6	1	1	3	6	5	4	2	4	55	4.6	3.1
Fawn	2	4	9	10	9	9	0	5	2	5	3	4	62	5.2	3.3
Unclassed deer	12	20	16	15	13	12	9	15	10	19	10	27	178	14.8	5.2
Total	38	88	92	59	58	65	37	60	50	66	35	74	722	60.2	18.6
Miles traveled	14	13	17	15	12.2	14	6.5	15	15	15	15	15	166.7	13.9	
Km traveled	22.5	20.9	27.4	24.1	19.6	22.5	10.5	24.1	24.1	24.1	24.1	24.1	268.3	22.4	
Deer/10 mi	27.1	67.7	54.1	39.3	47.5	46.4	56.9	40	33.3	44	23.3	49.3	529.2	44.1	12.6
Deer/10 km	16.9	42.1	33.6	24.4	29.5	28.9	35.4	24.9	20.7	27.3	14.5	30.7	328.8	27.4	7.8

Deer numbers on AAFB were not statistically different between FY93 and FY94 (Mann-Whitney U-Test, $U' = 78.5$, $n_1=12$, $n_2=12$, $p>0.05$). The average number of deer seen per count decreased slightly to 55.7 in FY94 from 57.3 in FY93 (Table 4). The largest single nightly count during FY94 was 82 in FY94, compared to a high of 90 in FY93.

Water Buffalo

Results of water buffalo counts made incidentally to deer counts are given in Appendix 1.

Table 4. Composition of deer herd seen during spotlight counts at Andersen Air Force Base, FY94.

		93 94												Total	Ave	SD
	COUNT	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep			
Unclassed buck	1	0	1	0	2	0	1	2	1	4	3	3	3	20	2	1
	2				0				3	3	4			10	3	2
	3									2				2	2	
	4									6				6	6	
Uncl. buck	Ave.	0	1	0	1	0	1	2	2	3.8	3.5	3	3	20	2	1
Spike	1	1	2	1	1	4	3	2	2	3	2	4	4	29	2	1
	2				1				4	2	5			12	3	2
	3									3				3	3	
	4									1				1	1	
Uncl. spike	Ave.	1	2	1	1	4	3	2	2.5	2.3	3.5	4	4	30	3	1
2pt	1	1	1	2	0	1	0	2	1	0	0	3	2	13	1	1
	2				0				3	0	1			4	1	1
	3									1				1	1	
	4									0				0		
2 pt	Ave.	1	1	2	0	1	0	2	0.8	0.3	0.5	3	2	14	1	1
3pt	1	2	2	0	0	1	2	3	2	1	2	4	4	23	2	1
	2				0				3	4	2			9	2	2
	3									12				12	12	
	4									2				2	2	
3 pt	Ave.	2	2	0	0	1	2	3	2.5	4.8	2	4	4	27	2	2
4pt	1	1	1	0	0	0	0	1	0	0	0	0	0	3	0	1
	2				1				3	0	0			4	1	1
	3									1				1	1	
	4									0				0		
4 pt	Ave.	1	1	0	1	0	0	1	1.5	0.3	0	0	0	5	0	1
Doe	1	29	25	11	1	19	32	18	25	28	28	22	33	271	23	9
	2				9				37	37	38			121	30	14
	3									32				32	32	
	4									36				36	36	
Doe	Ave.	29	25	11	5	19	32	18	31	33	33	22	33	291	24	9
Yearling	1	6	4	5	1	1	1	3	5	7	8	9	5	55	5	3
	2				1				8	7	11			27	7	4
	3									3				3	3	
	4									7				7	7	
Yearling	Ave.	6	4	5	1	1	1	3	6.5	6	9.5	9	5	57	5	3
Fawn	1	7	2	4	1	2	2	4	1	3	0	8	3	37	3	2
	2				1				5	4	9			19	5	3
	3									4				4	4	
	4									4				4	4	
Fawn	Ave.	7	2	4	1	2	2	4	3	3.8	4.5	8	3	44	4	2
Uncl. deer	1	17	20	11	8	14	11	21	11	14	23	37	18	205	17	8
	2				14				19	24	29			86	22	7
	3									25				25	25	
	4									21				21	21	
Uncl. deer	Ave.	17	20	11	11	14	11	21	15	21	26	37	18	222	19	8

Total	1	64	58	34	14	42	52	56	48	60	66	90	72	656	55	19
	2				27				85	81	99			292	58	43
	3									83				83	83	
	4									77				77	77	
Total	Ave.	64	58	34	21	42	52	56	67	75	83	90	72	668	56	18
	1	5	5	5	4	5	4	5	5	5	4	4.6	4			
	2				5				5	4	4.5					
	3									4						
	4									4						
Miles (Ave.)		5	5	5	5	5	4	5	5	4.2	4.3	4.6	4	56.1	5	
Km (Ave.)		8	8	8	7	8	6	8	8	6.7	6.8	7.4	6.4	88.3	7	
Deer/10 mi		128	116	68	42	84	130	112	134	179	195	196	180		119	
Deer/10 km		80	73	43	29	53	81	70	83	112	121	61	113		76	

RECOMMENDATION

Continue spotlight counts at present intensity at Naval Magazine and AAFB. Collect biological data from carcasses as available.

PROGRAM COST

The estimated cost of the deer population and distribution project under W-1R-2 is \$73,000.

LITERATURE CITED

Wheeler, M.E. 1979. The biology of the Guam deer, Tech. Rept. No. 3. Div. Aquatic and Wildl. Res., Dep. Ag., Mangilao. 53 pp.

Report prepared by: Tiffany Larscheid and Robert Beck

APPENDIX 1

The Population Size and Distribution of Wild Asiatic Water Buffalo on Guam

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

The abundance of wild (feral) Asiatic water buffalo (*Bubalus bubalis*) on Naval Magazine showed a significant increase during FY94.

RESULTS

Spotlight counts of Asiatic water buffalo, known locally as karabao, on the U.S. Naval Magazine were conducted incidental to deer counts. They were first initiated around 1966 by the Division of Aquatic and Wildlife Resources (DAWR). The size of the Magazine's herd remained fairly constant from 1966-1978, averaging about 0.6-0.8 animals/km traveled during counts (Anderson 1980). Numbers began to increase in 1979 and peaked in 1982, with a mean of 2.6 animals/km (DAWR 1980-1982). Buffalo abundance declined thereafter, falling to a mean of about 1.5-1.7 animals/km during 1986-1988 (DAWR 1983-1988). In 1987, Biosystems Analysis Inc. (1989) estimated the population on the base to contain 75-150 animals. Counts increased to an average of 2.5 animals/km in 1989 (DAWR 1989), then fell to 1.4-1.8 animals/km for 1990-1992 (DAWR 1990-1992). Numbers rose again in 1993 to 2.1 animals/km (DAWR 1993). Illegal hunting appears to be the major cause of mortality in the population (Conry 1988). High buffalo densities have resulted in localized habitat damage on Naval Magazine (Conry 1988, Biosystems Analysis Inc. 1989).

Methods used were the same as those used for deer counts (Project No. W-1R-2, Sub-project No. W-1, Study No. 1, Job No. 1). The average number of water buffalo seen per spotlight count on Naval Magazine showed a significant increase from 2.1 animals/km in FY93 to an all-time high of 2.7 animals/km in FY94 (Mann-Whitney *U*-Test, $U=33.5$, $0.05>P>0.01$) (Table 1). The mean number of animals seen per count in FY 1994 was 64.0 animals. The largest number of water buffalo recorded on a monthly count rose from 66 animals in FY93 to 99 animals in FY94. No additional work to assess population parameters of the Naval Magazine herd was done during the year because of limitations in manpower.

During the year, an article appearing in the *Pacific Daily News* noted the potential ecological problems caused by karabao at Naval Magazine and the estimated size of the herd. The story resulted in numerous inquiries to the Navy and Department of Agriculture from individuals interested in hunting or catching the animals for holding in captivity. The Navy held several meetings with the DAWR and the Guam National Wildlife Refuge to discuss management solutions. It was ultimately decided that no management emergency existed and that further study of over-browsing, soil erosion, and other problems was required.

It is noteworthy to point out that during FY94, a local farmer reported a herd of about 30 carabao regularly entering his fields on the north side of Cross Island Road (Route 17) near the Our Lady of Peace Memorial Gardens in southwestern Yona. He reported that the animals originated from the vicinity of Naval Magazine and crossed the highway at night to

visit his property. Apart from confirmation of tracks and droppings at the scene, no other observations were made by the DAWR to verify his report.

Table 1. Results of monthly spotlight counts of feral water buffalo at Naval Magazine, FY94.

Month	No. animals observed	Km traveled	Animals/ km	Miles traveled	Animals/ mile
Oct	37	22.5	1.6	14	2.6
Nov	58	20.9	2.8	13	4.6
Dec	67	27.4	2.4	17	3.9
Jan	79	24.2	3.3	15	5.3
Feb	61	24.2	2.5	15	4.1
Mar	50	22.5	2.2	14	3.6
Apr	58	22.5	2.6	14	4.1
May	78	24.2	3.2	15	5.2
Jun	67	24.2	2.8	15	4.5
Jul	48	24.2	2.0	15	3.2
Aug	66	24.2	2.7	15	4.4
Sep	99	24.2	4.1	15	6.6
Total	768	285.2	-	177.0	-
Ave	64.0	23.8	2.7	14.8	4.3
SD	16.32		0.65		1.05

LITERATURE CITED

- Anderson, R.D. 1980. Population size and distribution of wild carabao on Guam. Job Progress Report. Federal Aid to Fish and Wildlife Restoration, Guam. Guam Dept. Agric., Mangilao, Guam.
- Biosystems Analysis, Inc. 1989. Natural resources survey for the U. S. Naval Magazine, Guam (NavMag). Naval Facilities Engineering Command, Pearl Harbor, Hawaii.
- Conry, P.J. 1988. Management of feral and exotic game species on Guam. Trans. West. Sec. Wildl. Soc. 24:26-30.
- Division of Aquatic and Wildlife Resources. 1980-1993. Job Progress Reports. Federal Aid to Fish and Wildlife Restoration, Guam. Guam Dept. Agric., Mangilao, Guam.

Report prepared by: Gary J. Wiles

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-2
SUB-PROJECT NO.: W-1
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Population Size and Distribution of Wild Pigs on Guam (1460)

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

Official logs recording harvest statistics for Anderson Air Force Base (AAFB) indicated a substantial increase in numbers of hunter sorties, hunter days expended and number of pigs harvested. The number of hunter sorties reported increased 42.6% to 1696 from FY93. The number of hunter days and pigs harvested increased 39.5% and 23% to 715.8 and 68, respectively. Hunter and harvest statistics for Naval Computer and Telecommunication Area Master Station (NCTAMS) were incomplete due to the loss of the official log book by base security personnel. Hunter questionnaire responses for last year (FY93) indicated that an estimated 432 pig hunters harvested an estimated 1,603 pigs.

BACKGROUND

The wild pig (*Sus scrofa*) has long been an important natural resource on Guam and accounts for the greatest annual hunter recreation and harvest of all game animals. This species has been under investigation by the Division of Aquatic and Wildlife Resources (DAWR) since 1967 (Conry 1988). The wild pig on Guam is a descendant of domestic *Sus scrofa* introduced by the Spanish from the Philippines between 1672 and 1685. Wild pigs are found islandwide but appear to be most numerous in the limestone forests of the north and the ravine forests of southern Guam. Pigs occur at high enough densities in many areas that rooting and wallowing damage are common in most forested areas and can be quite severe locally. Depredation on agricultural crops is also a problem, particularly so for farmers in southern Guam during the dry season. Controlling the effects of pig damage is recognized as an important measure to protect native forest and agricultural resources. Recreational harvest is the primary tool used to control pig numbers and current hunting regulations provide for a year-round season with bag limits of two pigs per day and 40 per year. There is a need to consider more liberal regulations to control pig populations islandwide and in localized areas.

OBJECTIVES

To monitor trends in pig population size and hunter participation and harvest.

PROCEDURES

1. Record pig sightings during deer spotlight counts, and observations of pigs or pig sign during other fieldwork.
2. Monitor hunter participation and harvest during the legal hunting season.

RESULTS

Total hunting license sales decreased 8.5% during FY94, with 750 sold during the year. Hunt data were compiled for last year (FY93) by mailing out 819 hunter questionnaires this fiscal year. Based on 140 responses, an estimated 638 people hunted all species of game during the FY93 season (Table 1). An estimated 445 pig hunters, spent 5,242 days to harvest 1,620 pigs, or an estimated 3.2 days expended per pig taken.

Table 1. Summary of island-wide pig hunting statistics for FY93 derived from hunter questionnaires sent out in FY94.

a. Total license sales for all game species.	819
b. Number of questionnaires sent out.	819
c. Number of questionnaires returned.	140
d. Percent queried license buyers that responded.	17.1%
e. Number of reporting license buyers that hunted any species.	109
f. Percent of license buyers that hunted.	77.9%
g. Estimated total number of legal hunters.	638
h. Number of reporting hunters that hunted pigs.	76
i. Percent of reporting hunters (76) that hunted pigs.	70.0%
j. Number of successful pig hunters.	53
k. Hunter success.	70.0%
l. Number of pigs taken by the 53 successful hunters.	277
m. Average number of pigs taken per hunter.	3.6
n. Average number of pigs taken per successful hunter.	5.2
o. Hunter-days (8-hr) expended by reporting pig hunters.	896
p. Average number of days (8-hr) spent per reporting pig hunter.	11.8
q. Estimated total number of legal pig hunters.	445
r. Estimated total pig take.	1,603
s. Estimated total number of 8-hr days spent hunting pig.	5,242
t. Number of days spent hunting per pig taken.	3.2

Records of hunting activity and harvest were kept at AAFB and NCTAMS (Table 2). Data for AAFB includes the Conventional Weapons Storage Area (CWSA), which was opened for bow hunting only in November 1991. Based on hunter logs, Northwest Field recorded 1,559 hunter-days (3,264 hunter-sorties) and a harvest of 119 pigs (Table 2). Bow areas recorded 1,502 hunter-days (545 hunter-sorties) and a harvest of 124 pigs. CWSA recorded 421 hunter-days (917 hunter-sorties) and a harvest of 116 pigs.

Table 2. Hunter effort and pig take based on official hunter logs from NCTAMS and AAFB for FY94. NCTAMS hunting data were unavailable from October 1993 to May 1994.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
NCTAMS													
No. hunter sorties	-	-	-	-	-	-	-	76	97	134	152	331	790
No. hunter days (8-hr)	-	-	-	-	-	-	-	19.3	29.6	53.2	55.3	125	282.4
Pigs taken	-	-	-	-	-	-	-	4	9	12	8	16	49
Days effort/take	-	-	-	-	-	-	-	4.8	3.3	4.4	6.9	7.8	5.8

Andersen Air Force Base

Northwest Field

No. Hunter Sorties	723	236	546	543	405	54	20	24	39	71	30	573	3264
No. hunter days (8-hr)	360	102.	242	261	198	20.4	8.6	14.5	10	30.6	14.1	298	1559
Pigs taken	21	7	13	12	6	3	1	5	5	11	3	32	119
Days effort/take	17.1	14.6	18.6	21.7	33	6.8	8.6	2.9	2	2.8	4.7	9.3	13.1

Bow areas on main base

No. Hunter Sorties	130	47	125	251	209	79	67	79	82	69	149	215	1502
No. hunter days (8-hr)	46.7	28.3	40.6	92.9	70	35.1	26.6	30	32.3	26.1	65.8	97.5	545.4
Pigs taken	5	4	5	5	4	7	11	9	17	19	21	17	124
Days effort/take	9.3	7.1	8.1	18.6	17.5	5	2.4	3.3	1.9	1.4	3.1	5.7	4.4

CWSA

No. Hunter Sorties	130	24	100	121	23	43	62	71	43	71	59	100	847
No. hunter days (8-hr)	67.8	11.6	35.4	43.9	6.8	22.6	28.1	33.5	23.4	65.9	27.6	54.1	420.6
Pigs taken	5	3	5	8	0	11	9	15	11	30	12	7	116
Days effort/take	13.6	3.9	7.1	5.5	-	2.1	3.1	2.2	2.1	2.2	2.3	7.7	3.6

Comparison of hunting records for FY94 and FY93 indicates that Northwest Field had a 6% increase in the number of pigs harvested, jumping from 112 to 119 pigs. The number of hunter-days increased 39% from 1122 to 1559 hunter-days. Bow areas showed increases of 114% and 132% in the numbers of hunter days and hunter sorties, respectively, resulting in a 58% increase in the number of pigs harvested from 78 to 124. Although the number of hunter days in the CWSA decreased by 3%, the number of pigs harvested increased 15% from 101 to 116.

Hunting statistics for NCTAMS are incomplete because the hunter logbook was lost by base security personnel. Records were available only from May to September 1994, when 49 pigs were killed (Table 2).

RECOMMENDATIONS

Continue to monitor the annual pig harvest and hunter participation. Coordinate accurate record keeping and reporting of hunter effort and harvest at military bases.

PROGRAM COST

The estimated cost of the wild pig project under W-1R-2 is \$31,000.

LITERATURE CITED

Conry, P. J. 1988. Ecology of the wild (feral) pig (*Sus scrofa*) on Guam. Tech. Rept. No. 7. Div. Aquatic and Wildl. Res., Dep. Ag., Mangilao. 60 pp.

Report prepared by: Tiffany Larscheid

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-2
SUB-PROJECT NO.: W-2
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Population Numbers and Distribution of Philippine Turtle-Doves (1460)

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

The spring game bird surveys conducted this year showed no significant change in the relative abundance or distribution of Philippine turtle-doves (*Streptopelia bitorquata*) over last year's counts. The largest decrease in relative abundance occurred on Cocos Island, where the number of doves per station decreased by 1.90 for the second consecutive year. This makes a decrease of 75% on the island since FY91. Neither the monthly roadside counts in the Conventional Weapons Storage Area (CWSA) nor the call counts in Northwest Field (NWF) showed significant changes in abundance from FY93.

BACKGROUND

The Philippine turtle-dove was introduced to Guam by the Spanish during their early colonization of the region, circa 1771 (Baker 1951), and has been regulated as a game bird since at least 1903 (Conry 1987). Up through the early 1960s, the turtle-dove was very common and found in large numbers in both northern and southern Guam. By the late 1960s, dove populations in southern and central Guam began to decline and have since stabilized at low levels. Populations in northern Guam declined in the late 1970s and early 1980s. Turtle-doves are now found in appreciable numbers in prime dove habitat on NWF, CWSA and elsewhere on Andersen Air Force Base (AAFB), and at moderate numbers in selected areas of central and southern Guam. A population still remains on snake-free Cocos Island. Predation by the brown tree snake (*Boiga irregularis*) is the major cause of nest loss (Conry 1988) and this introduced pest is thought to be responsible for the population decline. Because of the decline in numbers and the extremely poor nesting success, the Department of Agriculture officially closed the turtle-dove hunting season in March 28, 1987. The season will be reopened if nesting success improves and numbers recover to a level that can support recreational hunting.

OBJECTIVES

1. To determine present population levels and distribution and to monitor population trends.
2. To investigate nesting success and causes of nest failures.

PROCEDURES

Call-count and roadside-count surveys were conducted at NWF and the CWSA on AAFB. Both surveys were conducted nearly monthly in the early morning. The call-count survey consisted of counting the number and species of doves seen or heard during

a 5-minute period at 10 stations in NWF plus the number of doves seen enroute between stations. The roadside-count survey at CWSA involved counting the number of Philippine turtle-doves seen while driving at 25 km per hour along an established 32-km route.

Philippine turtle-doves were additionally surveyed during spring game bird counts along 23 routes throughout the island in June. These surveys consisted of 5-minute station counts of up to 10 stations per route, with the number of birds seen or heard recorded at each station. Results are summarized as the average number of birds detected per station.

The Philippine turtle-dove is also included in a twice monthly roadside-count of all birds conducted by DAWR staff in three areas of northern Guam. The results of these surveys are reported in Job W-1-3.

RESULTS

Population Surveys

Call-count surveys and roadside counts were continued at NWF and the CWSA on AAFB (Table 1).

Table 1. Results of Philippine turtle-dove surveys at Northwest Field (NWF) and the Conventional Weapons Area (CWSA) on Andersen Air Force Base, Guam, during FY94.

	NWF Surveys	CWSA Surveys
1993		
October	9	13
November	8	11
December	7	13
1994		
January	10	16
February	5	14
March	12	23
April	12	12
May	7	no data
June	no data	15
July	no data	13
August	15	12
September	5	5
Survey Average	9	13.3
Standard Deviation	3.3	4.8

The average number of birds per survey in NWF decreased insignificantly from 9.9 birds/survey in FY93 to 9.0 birds/survey in FY94 (Mann Whitney U-Test, $n_1 = 10$, $n_2 = 11$, $U = 59.5$, $p > 0.05$). Similarly, roadside counts in the CWSA decreased insignificantly from 14.5 birds/count in FY93 to 13.3 birds/count in FY94 (Mann Whitney U-Test, $n_1 = 11$, $n_2 = 11$, $U = 68.5$, $p > 0.05$).

Spring Game Bird Surveys

Philippine turtle-doves were recorded on 21 of 23 spring game bird surveys in June 1994 (Table 2). The only surveys which had station counts of ≥ 1.0 birds per station were the Navy Golf Course (1.60), Cocos Island (1.40), and Mt. Santa Rosa (1.00). Snake-free Cocos Island no longer continued to have the highest count; Cocos Island recorded the largest annual decrease of 1.90 birds per station, equaling its annual decrease for FY93.

This year's Cocos Island survey marks a decrease of 75% from FY91 (5.70 birds per station), which is likely the result of habitat alteration by multiple typhoons in 1992 and increased resort development. The largest increase in birds per station occurred on the Toto Pipeline and Navy Golf Course surveys (0.77 and 0.70, respectively). The overall number of increasing and decreasing counts was similar to FY93 with 13 increasing, 9 decreasing and 1 unchanged (FY93; 12, 8, 3). There was no significant change from last year's survey (Wilcoxon Signed-Rank Test, $T_{0.5(2)23} = 119$, $p > 0.50$; Zar 1984).

RECOMMENDATIONS

1. Continue call-count and roadside count surveys in northern Guam to monitor distribution, relative abundance, and population trends of Philippine turtle-doves.
2. Keep the turtle-dove hunting season closed until nesting success improves and the population recovers.

PROGRAM COST

The estimated cost of the Philippine turtle-dove project under W-1R-2 is \$28,000.

LITERATURE CITED

- Baker, R.H. 1951. The avifauna of Micronesia, its origin, evolution, and distribution. University of Kansas Pub. 3(1):1-359.
- Conry, P. J. 1987. Ecology of the Philippine Turtle-Dove on Guam. Tech. Report No. 6. Div. Aquatic and Wildl. Res., Dep. Ag., Mangilao.
- Conry, P. J. 1988. High nest predation by brown tree snakes on Guam. Condor 90:478-482.
- Zar, J. H., 1984. Biostatistical Analysis. Prentice Hall, Inc., NJ.

Report prepared by: Tiffany Larscheid

Table 2. Numbers of Philippine turtle-doves detected per count and average number of birds per station on spring game bird surveys at various locations on Guam in June 1994. Values in the trend column are the difference between the average station count between years.

Survey Location	No. Stations	No. Doves Observed	1993 Ave./ Station	1994 Ave./ Station	Trend in Ave. 93-94
Tarague	10	4	0.60	0.4	-0.20
CWSA	10	9	0.80	0.9	0.10
NWF	10	6	0.60	0.6	0.00
NCTAMS	10	8	0.50	0.8	0.30
Capitol Improvement Road	10	5	0.40	0.5	0.10
Mt. Santa Rosa	10	10	1.20	1.0	-0.20
Y-Sengsong Road	10	3	0.60	0.3	-0.30
Two Lovers Point	10	1	0.00	0.1	0.10
Andersen South	10	7	0.20	0.7	0.40
Navy Golf Course Barrigada	10	16	0.90	1.6	0.70
Barrigada Hill	10	6	0.30	0.6	0.30
Toto Pipeline	8	9	0.13	0.9	0.77
Nimitz Hill	10	0	0.30	0.0	-0.30
Reserve Craft Beach Road	4	3	0.50	0.75	0.25
Orote Point	6	1	0.67	0.17	-0.50
Pulantat	10	9	0.40	0.9	0.50
Cross Island Road	10	3	0.20	0.3	0.10
Naval Magazine	10	6	0.50	0.6	0.10
Umatac	10	0	0.20	0.0	-0.20
Dandan	10	2	0.10	0.2	0.10
Ija	10	6	0.00	0.6	0.60
Merizo	8	3	0.63	0.38	-0.25
Cocos Island	10	14	3.30	1.4	-1.90

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-2
SUB-PROJECT NO.: W-2
STUDY NO.: 2
JOB NO.: 1

JOB TITLE: Population Size, Distribution and Hunter Harvest of Black Francolin on Guam (1460)

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

The annual spring game bird count recorded black francolin (*Francolinus francolinus*) in 17 of 23 surveys around the island. Seven survey routes recorded decreases, 10 routes recorded increases of one or more birds, and 6 routes had no change in the number of francolin per count. This pattern of change was statistically significant ($p < 0.001$) compared to FY93 counts. Francolin were recorded in 91% and 58% of southern and northern surveys, respectively. This species appears able to sustain the current levels of recreational hunting. Hunter questionnaire data for last year indicate that the estimated number of francolin hunters increased 110% over FY92. An estimated 1041 francolin were legally harvested in FY93.

BACKGROUND

In 1961, 171 black francolin were introduced in southern Guam as part of the Foreign Game Bird Introduction Program of the U.S. Fish and Wildlife Service. Surveys conducted in 1980 indicated the population was adequately established in most parts of southern Guam to open a hunting season. Regulations were promulgated to open a one-month season in December 1981, with a four-bird daily limit and a 20-bird season limit. Francolin populations continued to increase from 1980-1982, but hunting pressure remained low, probably because of the unfamiliarity of the hunting public with the sporting qualities of the bird. With the bird population consistently increasing and little hunting pressure, the francolin season and bag limits were further liberalized in FY83 to a two month-split season, one month in January and one month in July, and the bag limit was increased to 5 birds per day with no season limit. Revisions to the francolin season were again made in FY90 extending it from January 1 to February 28 and from July 1 to August 31. Francolin hunting has increased in popularity and Guam hunters are successfully harvesting birds during the open seasons. Regulations implemented in FY83 remain in effect with hunter participation and adherence to game laws monitored by spot checks by Division biologists and conservation officers.

OBJECTIVES

To determine current relative abundance and current distribution of black francolin on Guam and monitor population trends and hunter harvest.

PROCEDURES

1. Conduct annual island-wide spring game bird surveys to monitor distribution and status of francolin throughout the island.

2. Monitor hunter harvest via an annual harvest questionnaire. Collect information on hunter participation, effort, harvest, and areas hunted.

RESULTS

Spring Game Bird Surveys

Black francolin were detected on 17 of 23 spring game bird surveys in June 1994 (Table 1). The average number of birds detected per station increased on 10 survey routes and decreased on 7 routes from FY93 counts (Wilcoxon Signed-rank Test, $Z = -2.822$, $p < 0.001$). Changes in count results over last year indicate that the greatest number of decreases on counts occurred in the south, the greatest number of increases occurred in central Guam, and the least change occurred in the north. Francolin are still widespread in the south and appear to be in increasing numbers in central Guam. Francolin were found on 10 of the 11 surveys south of Route 4. Six of the 10 southern surveys with francolins recorded an annual decrease. Francolin were found on 7 of the 12 routes in northern Guam.

The Merizo survey route continued to have the highest station count this year with an average of 6.62 birds/station (Table 1). The Navy Golf Course recorded the highest relative increase in birds of 3.20 birds/station.

Table 1. Numbers of black francolin detected per count and average number of birds detected per station on spring game bird surveys at various locations on Guam during June 1994. Values in the trend column are the difference between the average station count between years.

Survey Location	No. Stations	No. Birds Observed	1994 Ave./ Station	1993 Ave./ Station	Trend in Average 93-94
Tarague	10	0	0.00	0.00	0.00
CWA	10	0	0.00	0.00	0.00
NWF	10	0	0.00	0.00	0.00
NCTAMS	10	11	1.10	0.90	0.10
Capital Improvement Road	10	4	0.40	0.00	0.40
Mt. Santa Rosa	10	0	0.00	0.00	0.00
Y Sengsong Road	10	0	0.00	0.00	0.00
Two Lovers Point	10	22	2.20	2.30	-1.00
Andersen South	10	5	0.50	0.10	0.40
Navy Golf Course	10	41	4.10	2.90	1.20
Barrigada Hill	10	27	2.70	2.30	0.40
Toto Pipeline	8	3	0.30	0.00	0.30
Nimitz Hill	10	52	5.20	2.00	3.20
Reserve Craft Beach Road	4	1	0.10	0.00	0.10
Orote Point	6	11	1.10	1.83	-0.73
Pulantat	10	46	4.60	4.80	-0.20
Cross Island Road	10	21	2.10	3.80	-1.70
Naval Magazine	10	49	4.90	5.10	-0.20
Umatac	10	39	3.90	5.00	-1.10
Dandan	10	36	3.60	3.20	-0.40
Ija	8	45	4.50	4.25	0.25
Merizo	8	53	6.62	5.38	1.24
Cocos Island	10	0	0.00	0.00	0.00

Black Francolin Hunting Statistics

Total hunting license sales decreased 8.5% during FY94, with 750 sold during the year. Hunt data were compiled for last year (FY93) by mailing out 819 hunter questionnaires this fiscal year. Based on 140 responses, an estimated 638 people hunted all species of game during the FY93 season (Table 2). There was an estimated 187 francolin hunters in FY93, an increase of 108% over FY91 (DAWR 1992). Also increasing was the percentage of francolin hunters among all legal hunters from 22% in FY91 to 29% in FY93. Hunters harvested an estimated 1041 birds during 1299 hunter days resulting in an estimated 1.25 days expended per bird taken.

Table 2. Summary of island-wide black francolin (BLFR) hunting statistics for FY93 derived from hunter questionnaires.

	Jan-Feb 93	Jul-Aug 93	Total
a. Total license sales for all game species.			819
b. Number of questionnaires sent out.			819
c. Number of questionnaires returned.			140
d. Percent queried license buyers that hunted any species.			17%
e. Number of reporting license buyers that hunted any species.			109
f. Percent of license buyers that hunted.			78%
g. Estimated total number of legal hunters.			638
h. Number of reporting hunters (109) that hunted BLFR during the regular season.	18	14	32
i. % of reporting hunters that hunted BLFR during the regular season.	17%	13%	29%
j. Number of successful hunters.	18	13	31
k. Hunter success.	100%	93%	97%
l. Number of BLFR taken by reporting hunters.	109	69	178
m. Average number of BLFR taken per hunter.	6.1	4.9	5.6
n. Average number of BLFR taken per successful hunter	6.1	5.3	5.7
o. Reported number of days spent hunting.	135	87	222
p. Average number of days spent hunting.	7.5	6.2	6.9
q. Estimated total number of legal BLFR hunters.	105	82	187
r. Estimated total legal BLFR harvest	638	404	1041
s. Estimated total number of days spent hunting.	790	509	1299
t. Number of days spent hunting per BLFR taken.	1.24	1.26	1.25
u. Number of BLFR taken per day hunting.	0.81	0.79	0.80
v. Number of 5-bird daily limits.	4	5	9

Noteworthy Records of Black Francolin

A male francolin was heard and seen on numerous occasions on the main airfield of Andersen Air Force Base in the vicinity of Pati Point between May and August. This is the first record ever of a francolin on the airfield. In February, another male was heard calling from a heavily disturbed vacant lot just east of the old borrow pit near Tamuning Elementary School. A female with several medium-sized chicks was seen on 27 February at Mt. Jumallong Manglo.

RECOMMENDATIONS

1. Continue to monitor francolin population status, distribution, and hunter harvest.
2. Increase the response rate of annual hunter questionnaire.

PROGRAM COST

The estimated cost of the black francolin project under W-1 R-1 is \$26,000.

LITERATURE CITED

Division of Aquatic and Wildlife Resources. 1992. Job Progress Report. Federal Aid to Fish and Wildlife Restoration. Div. Aquatic Wildl. Res., Dep. Agric., Mangilao.

Report prepared by: Tiffany Larscheid

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-2
SUBPROJECT NO.: W-4
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Survey and Inventory of Non-Game Birds (1460)

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

Monthly roadside counts for native forest birds, cave censuses for island swiftlets (*Aerodramus vanikorensis*), and surveys at Fena Reservoir for Mariana common moorhens (*Gallinula chloropus guami*) continue to document the population trends of Guam's birds. Roadside counts in northern Guam recorded only one species of native forest bird (Mariana crows, *Corvus kubaryi*), plus six other species of resident and migrant birds. An average of 5.75 moorhens was recorded per count at Fena Reservoir, with a high of 10 birds and low of 2 birds. Censuses of swiftlets at Mahlac Cave ranged from 400-465 birds during the year. Fachi Cave held an estimated 55-70 swiftlets in August, but numbers fell in September when the cave was nearly closed due to flooding. Only 18 crows were recorded in the annual crow survey, but at least 22 other known birds went undetected. The total crow population estimate for the island is about 40 birds, which represents a decline of about 10 birds since last year. Miscellaneous observations of Micronesian starlings (*Aplonis opaca*) are given.

BACKGROUND

Since the early 1960s, census data has documented the decline in both range and numbers of Guam's native land birds. Roadside counts initiated in 1960 over four routes in southern, central, and northern Guam by the Division of Aquatic and Wildlife Resources (DAWR) have provided an index to the decline (DAWR 1974-1993). From 1979-1981 population trends were monitored using variable circular-plot counts in central and northern Guam (DAWR 1980-1982). In 1981, an intensive forest bird survey was conducted by the U.S. Fish and Wildlife Service and the DAWR (Engbring and Ramsey 1984). Some of these transects used in 1981 were repeated from 1982-1988 by the DAWR (1982-1988). From 1963-1968, 54 monthly surveys were made at Fena Reservoir for moorhens. In 1987, monthly surveys at Fena were reinitiated and more regular surveys of other wetlands used by moorhens began. Also in 1987, surveys of island swiftlets were begun at the major remaining nest cave on Naval Magazine. Predation by brown tree snakes (*Boiga irregularis*) is the major factor contributing to the decline of Guam's native bird populations (Conry 1988; Savidge 1986, 1987).

OBJECTIVES

To continue status surveys and natural history studies as called for in the recovery plans for Guam's endangered native birds (Beck and Savidge 1990, U.S. Fish and Wildlife Service 1991a, 1991b).

PROCEDURES

1. Roadside counts were conducted at biweekly intervals on three routes (North, North-Central, and Northwest Field [NWF]; see previous annual reports for locations of routes) in northern Guam by DAWR conservation officers. These routes were driven at approximately 6-9 kph beginning at sunrise. Numbers and species of all birds seen or heard were recorded, irrespective of the distance from the observer.
2. Monthly surveys for Mariana common moorhens were conducted at Fena Reservoir on Naval Magazine. Two or three observers paddled a canoe to the southern end of the reservoir before sunrise. The count began shortly after sunrise with the canoe paddled northward along the shorelines, into bays, and up tributaries. Locations of moorhens seen and heard were recorded.
3. Regular counts of island swiftlets were attempted at Mahlac Cave on Naval Magazine. Observers sat at both entrances of the cave for a period of 1-2 hours before dark and recorded the numbers of birds flying in and out. The total number of birds inhabiting the cave was determined by subtracting the number of departures from the number of arrivals and by adding the number of birds estimated to be in the cave at the start of the count. Prior to each count, observers entered the cave for 0.5-1 hour to look for evidence of nesting and reproductive activity. The presence of nestlings and their calls and the incidence of adult birds that appeared to be incubating eggs or brooding young was noted. To avoid disturbing nesting birds, nests were viewed from a slightly elevated position off to the side of the cave rather than by lifting a mirror up to look inside the nests. The cave floor was searched and cleaned each month of eggshell fragments and whole eggs that had fallen from nests overhead.
4. Recorded-call playback surveys for Mariana crows were conducted in northern Guam. At each station, tape-recorded calls were played for 2.5 minutes. This was followed by a 2-minute silent period during which the observer listened for crows. The numbers, distance, and plumage condition of the crows observed were recorded.

RESULTS

Roadside counts continue to document the status of birds in the northern half of Guam. Tables 1, 2, and 3 present monthly count data for FY94. Table 4 summarizes the data for all three routes during the year. Six species were observed on the North count (Table 1). The white tern, which was observed last year, was not recorded this year.

Table 1. The average number of birds observed each month on the North roadside counts in FY94. Cnt = the average number of birds for all counts combined.

Species	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total	Cnt
Yellow Bittern	0.0	0.0	0.0	No	0.0	0.5	0.0	0.0	0.0	0.0	0.0	0.0	1	0.05
Black Francolin	0.0	0.5	0.5		0.5	0.5	0.0	0.0	1.0	0.0	4.0	0.0	14	0.70
Pacific Golden Plover	3.0	15.5	9.5	D	1.5	23.5	54.0	1.0	0.0	4.0	5.0	18.0	195	9.75
Philippine Turtle-Dove	1.5	0.0	0.5	A	1.0	0.0	1.0	0.3	1.5	0.0	0.5	4.0	16	0.80
Black Drongo	6.0	0.0	0.5	T	1.5	2.0	1.0	1.0	2.0	0.0	1.0	0.0	30	1.50
Eurasian Tree Sparrow	0.5	2.5	0.0	A	6.5	42.5	7.0	5.7	8.5	0.0	9.5	12.0	176	8.80
Km Traveled	82.1	68.2	74.8		71.5	80.5	36.2	118.1	76.8	38.6	78.9	38.0	763.6	
Counts	2	2	2	0	2	2	1	3	2	1	2	1	20	

Four species were observed on the NWF route (Table 2). The Pacific golden plover, Philippine turtle-dove, and black drongo showed increases, while the Mariana crow decreased when compared to FY93. Only one crow was seen this year compared to six last year. Micronesian starlings were observed on this route in FY93, but were not detected this year.

Table 2. The average number of birds observed per month on the Northwest Field roadside counts in FY94.
Cnt = the average number of birds for all counts combined.

Species	Oct.	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total	Cnt
Pacific Golden Plover	49	49	31.5	No	22.5	16.5	22	0	0	0	7	16	389	20.47
White Tern	0	0	0	D	0	0	0	0	0	0	0	0	0	0.00
Philippine Turtle-Dove	2	2.5	1	A	2.5	2	1	2	6.5	6	4.5	5	58	3.05
Black Drongo	3.5	4.5	0	T	1.5	2.5	1	2	6	3	4	2	54	2.84
Mariana Crow	0	0	0	A	0	0	0	0	0.5	0	0	0	1	0.05
Km Traveled	38.6	32.5	34.9		37.8	37.3	17.7	36.9	32.2	18	35.1	18.3	339.4	
Counts	2	2	2	0	2	2	1	2	2	1	2	1	19	

Six species were noted on the North Central route (Table 3).

Table 3. The average number of birds observed per month on the North Central roadside counts in FY94.
Cnt = the average number of birds for all counts combined.

Species	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total	Cnt
Yellow Bittern	0.5	0.	0	0	1	0.5	1	0	0	0	4	2	15.	0.79
Black Francolin	1.5	5	0	11	2.5	0	0	6	6	0	4	3	58	3.05
Pacific Golden Plover	4.5	0.	7	1	8.5	21.5	12	0	0	0	0	0	96	5.05
Philippine Turtle-Dove	3.5	7.5	1.5	11	0	6	3	4	18	4	2	2	87	4.58
Black Drongo	0.5	9	1.5	1	0	0.5	1	2	8	6	0.5	12.	56	2.95
Eurasian Tree Sparrow	16	10.5	6	3	10	7	2	24.5	112	7	8	16	304	16.00
Km Traveled	41.8	41.5	41.0	20.1	41.8	43.5	19.3	40.2	21.1	22.2	41.0	20.1	393.8	
Counts	2	2	2	1	2	2	1	2	1	1	2	1	19	

The yellow bittern, Philippine turtle-dove, black drongo, and Eurasian tree sparrow increased in abundance, while the black francolin and Pacific golden plover showed decreases when compared to FY93. White terns and Micronesian starlings were not observed on the route this year.

Common Moorhens

Regular moorhen surveys were continued at Fena Reservoir during FY94 (Table 5). Surveys averaged 5.75 moorhens per count, with a range of 2-10 birds per count. Sixty-nine percent (32 of 46) of all birds were recorded in the southern third of the reservoir, where shallower water allows some areas for emergent vegetation to become established. Little reproduction appears to be occurring at Fena. Only one nest was found during the year; four juveniles and no chicks were seen during surveys (Table 5).

Common moorhens were observed at a wetland on Naval Air Station for the first time ever. The site was vegetated primarily with *Panicum muticum*. Sightings of two to three birds occurred in August and September after rains flooded the site.

Former staff biologist, Michael Ritter, completed field research as partial fulfillment for a Master's degree. His study examined the characteristics and use of 33 wetlands where moorhens have been recorded sometime in the last 20 years. The results of his study should be available in 1995.

Table 4. Results of North, Northwest Field (NWF), and North-Central (N-C) roadside counts showing the mean number of birds per 100 km of travel and the standard deviation (SD).

Species	North No/100 km	SD	NWF No/100km	SD	N-C No/100 km	SD
Yellow Bittern	0.13	0.15	0.00	0.00	3.81	1.20
Black Francolin	1.83	1.16	0.00	0.00	14.73	3.37
Pacific Golden Plover	25.54	15.87	114.61	17.94	24.38	6.75
Philippine Turtle-Dove	2.10	1.16	17.09	1.97	22.09	5.00
Black Drongo	3.93	1.70	15.91	1.71	14.22	4.12
Mariana Crow	0.00	0.00	0.29	0.15	0.00	0.00
Eurasian Tree Sparrow	23.05	11.95	0.00	0.00	77.20	30.11

Table 5. Numbers of common moorhens and nests recorded during surveys at the Fena Reservoir in FY94.

Date	Adults	Juveniles	Chicks	Unknown	Total birds	No. of nests	Reservoir water level (ft)
13 Oct 93	5	3	0	0	8	0	107
10 Nov	2	0	0	0	2	0	109
7 Dec	3	0	0	2	5	0	112
14 Jan 94	1	0	0	2	3	0	-
5 Apr	7	0	0	1	8	0	106
13 May	9	1	0	0	10	1	101
8 July	4	0	0	4	8	0	100.5
26 Aug	1	0	0	1	2	0	112

Native Doves

A white-throated ground-dove was heard calling in the Conventional Weapons Storage Area of AAFB on 25 June and 18 July.

Island Swiftlets

Mahlac Cave - Only five censuses of island swiftlets were completed at Mahlac Cave in FY94 (Table 6). Counts ranged from 400-465 birds, which is similar to the estimate of 425-450 birds made in late FY93 (DAWR 1993). Increased swiftlet activity at the north entrance of the cave from May-September 1994, when up to 500 birds flew in and out of the opening during some 10-minute periods, necessitated the use of three observers during censuses. Two people, one counting bird entries and the other counting exits, worked this entrance. This was expected to improve count accuracy. In August, 400 swiftlets were recorded. However, a disturbance during the "final rush" period of the September count resulted in a questionable final tally of 465 birds. Continued censuses with three observers in FY95 should further clarify the size of the colony.

Reproductive activity was again monitored during the year. Observations verified work from previous years (DAWR 1987-1993), with most reproduction beginning in January and continuing until October. Four nesting parameters determined from 68 nests viewed each month were highest from late January through September (Table 6).

Table 6. Results of censuses for island swiftlets at Mahlac and Fachi Caves on Naval Magazine during FY94. Evidence of reproductive activities of swiftlets is also presented.

Date	Reproductive Parameters							
	Net No. of Birds Entering Cave	No. of Birds Estimated in Cave at Start of Count	Total No. of Birds Counted	No. of Whole Eggs Found on Cave Floor	No. of Eggshell Fragments on Cave Floor	No. of Nestlings Heard	No. of Nestlings Seen	Incubation or Brooding Observed
Mahlac Cave								
1 November 1993	-	-	-	1	0	4-5	5-7	undetermined
6 December	-	-	-	0	0	2-3	8	undetermined
5 January 1994	448	17	465	3	2	2	2	undetermined
31 January	417	31	448	3	17	2-3	11	yes
28 February	439	16	455	6	15	4-6	21	undetermined
29 March	-	-	-	7	26	4	14-15	undetermined
28 April	-	-	-	6	26	4-5	17	undetermined
31 May	-	-	-	11	33	4-5	24	undetermined
11 July	-	-	-	3	23	5-6	15	undetermined
1 August	-	-	-	5	8	2-3	21	undetermined
31 August	370	30	400	4	7	2	14	yes
28 September	452*	13	465*	0	6	3-4	11	yes
Fachi Cave								
2 August 1994	53	-	55-70+	-	-	-	-	-

Key: - = no data gathered; * = accuracy of count is questionable; + = estimated number of birds present.

Snake activity in and around the cave remained high in FY94. Snake tracks in the cave's guano deposits were very common during nine monthly visits and moderately common during three visits. Twenty-two shed snakeskins were found outside the cave during the year. Three live snakes were caught on rock faces outside the cave. They were of the following sizes: 1) SVL = 1,055 mm, total length = 1,345 mm, wt = 128 gr, male; 2) SVL = 885 mm, total length = 1,180 mm, wt = 80 gr; and 3) SVL = 740 mm, total length = 945 mm, wt = 44 gr. Two of the animals had empty stomachs, while the third possibly had lizard parts in its gut.

The building of mud dauber nests on swiftlet nests was identified as a possible new conservation problem in FY93 (DAWR 1993). It was feared that the heavy weight of the daubers' mud nests might pull swiftlet nests off the walls of the cave. During FY94, we continued to observe mud nests being constructed on bird nests. During the year, 22 swiftlet nests fell to the cave floor, but only four of these had full or remnant mud dauber nests attached to them. A number of the cave's intact swiftlet nests have had mud dauber nests on them for more than a year now.

Fachi Cave - No complete censuses were conducted at Fachi Cave in FY94. However, a count of birds entering the cave at dusk was made from a location outside the main entrance on 2 August. Fifty-three swiftlets flew into the cave, suggesting a total of perhaps 55-70 birds were present (Table 6). This estimate is similar to numbers in previous years (FY91 to FY93), when 50-82 birds were present (DAWR 1990-1993). This year's count was made when flooding nearly closed the main entrance. Heavy rains in late July (rainfall = 46 cm for the month) resulted in water levels rising to within 60 cm of the entrance's roof.

Interestingly, the colony did not abandon the cave despite this near closure. Floodwaters receded rapidly after 2 August.

Heavy rains resumed during September, when 48 cm of rainfall fell during the month. This caused water levels at Fachi Cave to rise within 30 cm of the top of the cave's east entrance between 23-30 September. The west entrance was entirely closed off by water during this period. Despite the narrow size of the main opening, observations revealed that some birds were able to enter the cave without any noticeable problem. Most birds flew in at the widest part of the opening, but in one astonishing observation, a swiftlet was able to fly through a narrow 10-cm tall portion of the opening without touching the water. Observers swam into the cave at midday on 23 and 26 September and found one bird in the cave on the first visit and no birds on the second visit. A complete census of the colony was not made during this period, but an arrival count was made on the evening of 3 October 1994. An undetermined number of swiftlets were already in the cave at the start of the count, plus an additional 14 flew inside from 1750-1840. This suggests that only a portion of the colony continued to reside in the cave. Several birds had difficulty entering the cave and eventually gave up after circling the entrance for 5-10 min. Because of near darkness, these birds likely roosted outside in the forest rather than flying to Mahlac Cave. Of further interest, no dead swiftlets were found floating in the cave on any of the three visits made inside. A search of the nest chamber revealed only remnants of nests clinging to the walls. It is not known what process may have caused the deterioration of the nests.

Previously, we speculated that the colony might easily be trapped in the cave at night if additional heavy rains were to fall and entirely close the east entrance. Further examination of the cave in September revealed that the birds may have an escape route through several small openings in the ceiling of the first chamber of the cave's east entrance. Enough light shows through the openings that the swiftlets must be aware of their presence. However, the openings are probably too small to prevent any birds from re-entering the cave after their departure.

Other Localities - Swiftlets were observed foraging over the east-central shore of the Fena Reservoir during two moorhen counts in FY94. The sightings involved a flock of 6-9 birds on 7 December and 1-2 birds in the same area on 4 February. These are the first swiftlet sightings at Fena since 1987, with none seen on 38 moorhen counts at the lake in the intervening years. Another unusual swiftlet sighting occurred in the upper Chagame River valley, Umatac, on the southern slopes of Mt. Jumallong Manglo on 19 May. No searches were made during FY94 for the suspected swiftlet colony in the Lumuna region of Yigo.

A visit to the island swiftlet cave in the North Halawa Valley on Oahu, Hawaii was made on 29 November 1993. This colony originated from birds translocated from Guam in the early 1960s and is the only nesting location known in the state of Hawaii. The colony has great conservation significance in that it is a possible source of birds for reintroduction to Guam if the species disappears here. The colony resides in an old man-made tunnel next to the base of a waterfall. Unfortunately, the cave appears only marginally suitable as a nesting and roosting site. It is long, narrow, and fairly straight, and much of its floor was flooded with 2-13 cm of water. Dimensions are 60 m long, 1.5-1.8 m tall, and 1.2 m wide. It held only 10 nests, all of which were located at the rear of the cave in the last 11 m. We estimate that only 25-35 birds may reside in the colony and conclude that the colony is quite vulnerable to extirpation.

Mariana Crows

Fourteen transects totaling 209 stations were used to survey crows in eight regions of northern Guam during July (Table 7). Transect locations were previously described in DAWR (1990, 1991). Crows were present on eight (57%) transects, which is an increase of one transect from last year. A total of 18 crows was recorded during playback surveys, a decrease of 64% from last year's total of 51. Transect 1 through the CWSA continued to have the most crows (6 birds), but decreased by 12 birds from last year (DAWR 1993). Transect 2 in NWF recorded three crows. Transect 7 on Pati Point recorded a drop from seven birds in FY93 to two birds in FY94.

Table 7. Summary of results from playback of tape-recorded Mariana crow calls conducted in July 1994. Transect locations are described in DAWR (1990, 1991).

Transect	No. of stations	No. of crows	No. of stations with crows	Known no. of crows missed in survey
1	50	6	6	5
2	36	3	2	3
3	12	1	1	0
4	10	0	0	0
5	8	1	1	0
6	11	0	0	0
7	10	2	1	6
8	23	0	0	0
9	8	2	1	2
10	9	1	1	0
11	7	2	1	0
12	8	0	0	0
13	8	0	0	4
14	9	0	0	2
Total	209	18	14	22

$$\text{Population estimate} = 18 + 22 = 40 \text{ birds}$$

The number of crows detected during the FY94 survey is much lower than the actual number of birds still surviving. For example, a family group of three crows known to exist in the area was not recorded on Transect 2 in NWF. In the CWSA, Transect 1 is believed to have 5 additional birds that were overlooked in the survey. There are at least four known pairs of crows in the Pati Point area that were missed during the survey. When the number of unrecorded birds (22 birds; Table 1) is added to the number of individuals recorded during the survey, an estimate of about 40 birds is obtained and represents a better approximation of the actual size of the population. However, this estimate still suggests a population decrease of 20% (or least 10 birds) during the last year.

Figure 1 summarizes the results of annual playback surveys made since 1990. The population shows a downward trend even though numbers remained relatively stable at about 50 birds from 1991-1993. Results from the FY94 survey suggest that the population has decreased further and that the status of the crow population on Guam has become even more critical.

Two crow chicks were fledged during the FY94 crow breeding season as a result of nest protection efforts. Electrical barriers were used to protect 28 crow nests from snake predation during this nesting season, with three young hatched, of which two fledged. Twenty-one nests were abandoned without eggs being laid or incubation observed. Clutch

sizes of the seven remaining nests were as follows: one clutch of one egg, two clutches of two eggs, and four clutches of three eggs. Of these nests, four clutches failed to hatch, one was dumped, and two successfully hatched and fledged young. The number of eggs that failed to hatch (13) indicates that other problems are affecting the reproductive success of the population in addition to snakes. Eight eggs that failed to hatch from four clutches were collected. Six eggs showed no signs of embryo development and possibly were infertile. Two were fertile, with one having a late dead embryo. This year's results strongly suggest that additional interventive approaches (e.g., artificial incubation and cross fostering) are needed to enhance production and recover the species on Guam.

ANNUAL CROW SURVEY



Figure 1. Summary of Mariana crow playback surveys conducted on Guam from 1990 to 1994. Only 18 birds were recorded during the 1994 survey, however, the estimated number of crows is actually about 40 birds.

Micronesian Starlings

Miscellaneous observations of starlings were made on AAFB during FY94. This population extends into northern Yigo and is the largest remaining population on Guam (Wiles et al., in prep.). A compilation of nesting records for the year is provided here. Two old nests were found in horizontal roof-top drainage pipes at the AAFB fire station. Both pipes were 13 cm wide by 14-18 cm tall. One of the nests reportedly held two large chicks in early November, but the young were apparently killed by a pair of escaped Indian hill mynas (*Gracula religiosa*) (see below). Adult starlings were seen entering the hollow tops of two wooden telephone poles in the housing area during the year. Another bird was seen carrying nesting material to a nest being built in the crown of a live coconut tree on 8 August. On 13 June, a nest under construction was found in the hollow top of a dead coconut tree trunk. Only an outer nest cup consisting mainly of *Casuarina* needles and narrow strips of coconut leaves was present. The tree was located in base housing and was cut down immediately after examination. Because the Air Force's buildings and grounds department has expressed a strong need to remove badly rotten coconut trees before the onset of each typhoon season, the DAWR suggested that the Air Force initiate a nest box program to determine the acceptability of artificial nests to starlings. A small number of nest boxes are to be built and set up in FY95.

On several days in March, starlings were regularly encountered in the extensive tract of limestone forest east of the base's golf course. This forest is likely to be an important feeding area for the population.

A pair of hill mynas, assumed to be escaped pets, roosted at the base's fire station for much of 1993 until March 1994. The mynas frequently associated with several starlings living in the area and also foraged in the forest east of the golf course. Fire station personnel implicated the mynas in the deaths of two nestling starlings at a nest in a drain pipe at the station. The carcasses of the nestlings were found on the ground below one of the nests, with the feathers removed from their backs and heads. Upon request by the DAWR, the Air Force shot one of the mynas in March 1994. The second bird disappeared soon after for unknown reasons.

Little time was devoted to starling observations on Cocos Island in FY94. Only three birds were recorded there on a Spring Game Bird Count, as compared with 10 individuals in FY93.

Seabirds and Reef-Herons at Cocos Island

No seabird censuses or observations of nesting by Pacific reef-herons (*Egretta sacra*) were made on Cocos Island in FY94. Large numbers of black noddies (*Anous minutus*) continued to be seen by fishermen in waters off southern Guam during most of the year.

Monitor lizards (*Varanus indicus*) and feral cats continue to pose a threat to nesting and roosting birds on the island, as well as to some of the rare lizard species present. Unfortunately, a small control program in which monitor lizards were hunted with pellet guns was discontinued in February because of manpower limitations. Between October and February, 15 half-day trips to the island resulted in three monitors killed, one wounded, and three others seen but not shot. One cat was seen on the island in October.

Notable Species Recorded on Guam during FY94

A variety of noteworthy bird sightings were made during the year. A red-tailed tropicbird (*Phaethon rubricauda*) was seen flying over Pati Point on 13 October. Single little egrets (*Egretta garzetta*) were observed at a fishpond at Agfayan Bay, Inarajan on 26 December and along the lower reaches of the Toguan River, Merizo on 22 May. A pair of egrets was also seen at Dungca's Beach, Tamuning on 9 January. These sightings continue a trend of annual observations of this species since 1987 (Wiles et al. 1993). A male gadwall (*Anas strepera*) in breeding plumage was seen at the upper pond of the Toguan Bay sewage treatment plant on 26 December. A Chinese goshawk (*Accipiter solensis*) was captured by a cat at a home in Northwest Field on 18 September and turned over to the DAWR.

Single snowy plovers (*Charadrius alexandrinus*) were recorded at Dungca's Beach on 4 December and 2 January. A ruff (*Philomachus pugnax*) was also seen there on 4 December. There was an unconfirmed sighting of a flock of six far Eastern curlews (*Numenius madagascariensis*) on Naval Station in early September. A pair of common black-headed gulls (*Larus ridibundus*) appeared at Dungca's Beach on 9 January. The autumn of 1993 produced a number of white-winged tern (*Chlidonias leucopterus*) sightings. An emaciated individual was caught by a conservation officer at Dungca's Beach on 1 October. Four birds were seen at a fish pond at Agfayan Bay on 12 October, with two individuals found on 24 October and another bird on 26 December. Another tern was seen at a pond at the Manengon Hills Resort, Yona on 4 November and 12 December. A white-winged tern fed in the flooded wetland behind the DAWR office in Mangilao on 20-22 September. A common tern was found exhausted on the beach at Tumon Bay on 18 September after the passing of a tropical depression. A yellow wagtail (*Motacilla flava*) was caught on Orote Peninsula on 13 October. A paper documenting recent bird records for Guam from 1987-1993 was published during the year (Wiles et al. 1993).

RECOMMENDATIONS

1. Develop and implement methods for controlling the brown tree snake.
2. Continue bimonthly roadside counts over the three routes in northern Guam.
3. Continue to monitor the population of common moorhens and develop an appropriate habitat improvement and development program.
4. Continue monthly cave censuses and efforts to assess population change and reproductive activity of island swiftlets. Consider snake-proofing Mahlac Cave to protect nesting swiftlets. Conduct further observations on the foraging behavior of swiftlets. Determine whether there is any seasonal variation in the foraging range of the colony. Interview farmers in the Talofofo River valley about the use of pesticides on their farms.
5. Continue to census the Mariana crow in order to estimate population size and distribution. Continue breeding biology studies and attempts to snake proof nest sites of crows.
6. Continue predator control efforts on Cocos Island until complete eradication of monitor lizards and feral cats is attained.

PROGRAM COST

The estimated cost of the non-game bird project under W-1R-1 is \$123,000.

LITERATURE CITED

- Beck, R.E., Jr. and J.A. Savidge. 1990. Recovery plan for the native forest birds of Guam and Rota. U.S. Fish Wildl. Serv., Portland, Or. 86 pp.
- Conry, P. J. 1988. High nest predation by the brown tree snake on Guam. Condor 90:478-482.
- Division of Aquatic and Wildlife Resources (DAWR). 1974-1992. Job Progress Reports - Federal Aid to Fish and Wildlife Restoration. Guam Dept. of Agriculture.
- Engbring, J. and F.L. Ramsey. 1984. Distribution and abundance of the forest birds of Guam: Results of a 1981 survey. U.S. Fish Wildl. Serv., Washington, D.C. FWS/OBS-84/20.
- Savidge, J. A. 1986. The role of disease and predation in the decline of Guam's avifauna. Ph.D. Thesis. University of Illinois, Urbana-Champaign.
- Savidge, J. A. 1987. Extinction of an island avifauna by an introduced snake. Ecology 68:660-668.
- U.S. Fish and Wildlife Service. 1991a. Recovery plan for the Mariana Islands population of the Vanikoro Swiftlet (*Aerodramus vanikorensis bartschi*). U.S. Fish Wildl. Serv., Portland, Or. 49 pp.

- U.S. Fish and Wildlife Service. 1991b. Recovery plan for the Mariana Common Moorhen (=Gallinule), *Gallinula chloropus guami*. U.S. Fish Wildl. Serv., Portland, Or. 55 pp.
- Wiles, G.J., C.F. Aguon, G.W. Davis, and D. Grout. in prep. The status and distribution of endangered wildlife and plants in northern Guam.
- Wiles, G.J., R.E. Beck, Jr., C.F. Aguon, and K.D. Orcutt. 1994. Recent bird records for the southern Mariana Islands, with notes on a colony of Black Noddies on Cocos Island, Guam. *Micronesica* 26:199-215.

Report prepared by: Celestino F. Aguon, Gary J. Wiles, and Tiffany L. Larscheid

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-2
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 1

JOB TITLE: Natural History, Biology, and Habitat Protection for Mariana Fruit Bats (1460)

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

During FY94, Guam's fruit bat population ranged in size from an estimated low of 275-320 animals in May to a high of 550-625 animals in January. This pattern, in which numbers peaked from December-February and were reduced from April-October, agrees closely with previous evidence of a fluctuating annual pattern in abundance that is probably related to inter-island movements of animals between Guam and Rota. Bat colonies used two roosts on Pati Point during the year. Observations revealed a continued lack of natural recruitment in the population. Several possible illegal hunting incidents were reported this year. The design and layout of a full-color fruit bat poster was completed. In FY94, 8,276 frozen fruit bats were imported to Guam from other islands for human consumption, a decrease of 24.3% from the previous year.

BACKGROUND

The Mariana fruit bat (*Pteropus mariannus mariannus*) has been studied by the Division of Aquatic and Wildlife Resources (DAWR) since 1962 (DAWR 1964-1993). Considered a delicacy by Chamorro residents, this bat steadily declined in numbers during the 1960s and 1970s until only a few solitary animals remained (Perez 1972, Wheeler and Aguon 1978, Wiles 1987a). A second species, the little Mariana fruit bat (*P. tokudae*), also occurred on the island, but is now extinct (Wiles 1987a). Reasons for the declines included: increased human population pressures that resulted in overhunting and habitat loss, commercial exploitation of bats as a food, the lack of an adequate enforcement, and delays by the local legislature in passing protective legislation (Wheeler 1979). Both *Pteropus* have been placed on the U.S. and Guam Endangered Species Lists. The island's population of Mariana fruit bats grew to an estimated 850-1,000 animals in the early 1980s, probably from immigration of bats from Rota (Wiles 1987a, Wiles and Glass 1990). However, numbers have gradually declined since 1983 because of continued illegal hunting and suspected predation on bats by brown tree snakes (*Boiga irregularis*) (Wiles 1987a, 1987b). Guam's fruit bat population was estimated at 310-355 animals in FY93 (DAWR 1993). The Guam National Wildlife Refuge (GNWR) was created on 1 October 1993 to protect fruit bats, other endangered species, and their habitat.

OBJECTIVES

To continue status surveys and natural history studies and to provide for continued protection of habitat as recommended in the Mariana Fruit Bat Recovery Plan (Wiles 1990).

PROCEDURES

1. Survey fruit bat distribution and numbers in Guam and the Commonwealth of the Northern Mariana Islands (CNMI) as initiated in the late 1970s.
 - a. Conduct annual surveys of fruit bats along Guam's northern cliffline with periodic surveys made elsewhere on the island. The emphasis of surveys should be to search for solitary bats and additional bat colonies.
 - b. Conduct monthly censuses at known bat colonies on Guam.
 - c. Assist the CNMI Division of Fish and Wildlife with surveys of fruit bats on other islands as needed.
2. Record information on the behavior and reproduction of fruit bats in colonies.
3. Determine habitat use of fruit bats. Visit abandoned roost colonies and record information about terrain and the size and abundance of vegetation present.
4. Monitor fruit bat imports to Guam from other Pacific islands.
5. Investigate illegal hunting of fruit bats on Guam. Visit abandoned roosting sites of colonies to determine illegal hunting effort. Assist conservation officers with investigations of bat poaching.

RESULTS

Locations of Bat Colonies on Guam

Fruit bat colonies were recorded at two locations on Pati Point in FY94. Roost 1, a long favored site (DAWR 1987-1993), was used by the main colony for much of the year (Tables 1 and 2). It was abandoned for unknown reasons for short periods in May and June. One inspection of the empty roost found no evidence of poaching or human intrusion. Roost 20 was occupied by bats from mid-October to early December and again from mid-May to early July. This site has been used regularly as an alternative roost since 1990 (DAWR 1990-1993). Aircraft activity or several days of southeasterly winds may have caused the colony to move from this location in July (see Aircraft-Fruit Bat Interactions).

John Morton, a biologist with the U.S. Fish and Wildlife Service (USFWS), reported the occurrence of a few bats along the Tarague Basin cliffline at a site approximately 2 km west of Tagua Point. Bats were regularly seen and heard there from March until the end of the reporting period, but an actual colony was never sighted. Observations during several visits by the DAWR revealed that a loose aggregation of perhaps only 10-20 bats was probably spread over a large area of a cliffside terrace.

Table 1. Approximate dates of use of two roosts used by colonies of Mariana fruit bats on Guam in FY94.

Roost Number	Roost location	Approximate periods of use by bats
1	North Pati Point	14 Aug 93-2 May 94, 17-27 May, 2 July - present
20	East Pati Point	8 Jun 93 -1 Oct, 13 Oct-7 Dec 93, 17 May-5 July 94

Surveys of Fruit Bats on Guam

In FY94, roost counts increased from about 200 bats in October to 414 animals in January (Table 2). Numbers slipped to 175 bats by late May, jumped slightly to 257 bats in late June, and then fell again to about 180-190 bats during August and September. This pattern follows a general trend noticed in recent years of large counts during the months of December-February and low counts from May-September. Data analyses indicate that numbers on Guam and Rota fluctuate inversely with one another and are highly suggestive of seasonal inter-island movements.

Table 2. Counts of Mariana fruit bats at roosts on Andersen AFB, Guam in FY94.

Date	Roost Number										Total
	1	2	14	15	16	17	18	19	20	21	
27 Sept 1993	70	-	-	-	-	-	-	-	130	-	200
6 Oct	208	-	0	0	0	0	0	0	0	0	208
20 Oct	101	-	0	0	0	0	0	0	84	0	185
21 Oct	+	-	-	-	-	-	-	-	140	-	x
17 Nov	245	-	-	-	-	-	-	-	10	-	255
28 Dec	361	-	0	0	0	0	0	0	0	-	361
27 Jan 1994	414	-	-	0	0	-	0	0	0	-	414
23 Feb	360	-	-	-	-	-	-	-	-	-	360
4 Apr	334	-	-	-	-	-	-	-	0	-	334
22 Apr	239	-	0	0	0	0	0	0	0	0	239
13 May	0	-	0	0	0	-	0	0	0	-	x
20 May	+	-	0	0	0	0	0	0	64	-	x
23 May	18	-	0	0	0	0	0	0	157	-	175
1 June	0	-	-	-	-	-	-	-	+	-	x
7 June	0	-	-	-	-	-	-	-	189	-	189
30 June	-	-	-	-	-	-	-	-	257	-	257
4 July	+	-	-	-	-	-	-	-	26	-	x
7 July	+	-	0	0	0	-	0	0	0	-	x
25 July	228	-	0	0	0	-	0	0	0	-	228
11 Aug	191	-	0	0	0	0	0	0	0	0	191
2 Sept	180	-	-	-	-	-	-	-	-	-	180

+ = Bats present at roost but no count made; - = site was not checked for bats; x = no total count made.

Estimates of fruit bat numbers at colonies on Pati Point can be made using the high and low roost counts for the year. Because some individuals were probably hidden by thick foliage during counts, the total number of adults in roosts was likely to be 10-20% higher than the actual number recorded. In addition, based on observations made in August (see Natural History), approximately 52% of the adults in the colonies were harem females. About 10% of these animals possessed unweaned young. These figures provide an estimated high of 455-497 adults and 24-26 juveniles, or a total of 479-523 bats during late January, and a low of 193-210 adults and 10-11 juveniles, or a total of 203-221 bats in late May.

Incidental daytime sightings of single fruit bats or pairs of bats were made during the year at Ritidian Point (numerous sightings by GNWR staff), Tarague basin and beach (9 sightings), the Conventional Weapons Storage Area on AAFB (3 sightings), Urunao Beach (2 sightings), a location about 300 m west of the north end of Fena Lake (1 sighting), the Chaot River valley near Route 4 in Sinajana (1 sighting), and the Conga-Maimai area of Chalan Pago (1 sighting). Only two nighttime sightings were reported, with one in the Conventional Weapons Storage Area and another at Tanguisson Beach. There were also several reports of bats at unknown hours in Mataguac, Yigo. The number of sightings at

Ritidian Point and Tarague indicates that a few solitary bats reside permanently in these areas.

Excluding bats residing in the colony at Pati Point, an estimated 50-75 fruit bats are still believed to live solitarily or in small groups in northern Guam, primarily along the cliffline extending from Bijia Point to Lates Point. An additional 25 animals probably inhabit Naval Magazine and other forested areas in southern and central Guam. Based on these figures, Guam's islandwide population of fruit bats varied from an estimated low of 275-320 animals in May to a high of 550-625 animals in January.

Surveys of Fruit Bats on Other Islands

The DAWR did not participate in bat surveys on other islands in FY94.

Natural History

Reproduction - Observations of harem females at Roost 1 were made during October and August to monitor the occurrence of young in the population. Females with young comprised 14.0% of the females observed (n=50) in October and 8.5% of the females in August (n=106). All young bats seen were small-sized.

Social Composition of the Colony - During extended observations in August, 59.2% of the bats in the colony (n=191) roosted in harems, 25.1% in bachelor male groups, and 15.7% as lone males. Females comprised 51.8% of the colony.

Aircraft-Fruit Bat Interactions

The threat of disturbances to roosting fruit bats by military aircraft became an increasingly important management concern during FY94. Previous observations have suggested that aircraft noise may occasionally disturb bats roosting in the vicinity of the airfield on AAFB and result in the abandonment of roosts. Concerns revolve primarily around fighter aircraft, which are more maneuverable and possibly louder than the bomber and transport planes that have long been assigned to the base. The Navy's desire to have transient fighter squadrons regularly use the base is cause for concern. In response, the USFWS stationed John Morton on island in February to conduct a two-year study on the effects of aircraft activity on fruit bats and Mariana crows (*Corvus kubaryi*).

Several observations are worthy of further documentation here. The abandonment of Roost 20 in July coincided with a several-week visit of a squadron of Navy fighters. No actual observations were obtained to verify that the planes caused the roost to be abandoned, and it is possible that several days of southeasterly winds at the same time may have been the real cause.

On 9 August, during a series of behavioral observations being made at the colony, three Navy F-18s in tight formation flew 1,000-1,500 feet above the forest at the east end of Pati Point. The planes made a loud and rapid initial pass over the airfield and then circled around to land quietly on their second approach. Although the noise of the first pass lasted just a few seconds, it caused nearly all of the bats in Roost 1 to awaken simultaneously and begin looking around. Some interactions among neighboring animals followed, but none of the bats took flight. This incident shows that although brief bursts of extremely loud engine noise may not cause animals to take flight or leave the roost, such noise can clearly affect roosting animals.

Illegal Hunting

Poaching has long been a major cause of mortality of *P. mariannus* in the southern Mariana Islands (Wiles 1987a, Wiles et al. 1989, Stinson et al. 1992). Poaching still occurs commonly on Rota (D. Worthington, pers. comm.). It is feared that the termination of bat imports from Palau in FY '95 will result in increased poaching activity throughout the archipelago (Wiles 1994).

Two possible cases of illegal hunting were reported on Guam in FY94. The DAWR received a report from an AAFB volunteer game warden several weeks after the fact that a single gunshot was heard in the vicinity of Roost 1 at 0700 on 21 March. It was never determined whether the shot came from the colony or from elsewhere in the surrounding basin. A large number of bats from the colony flew into the air, but no evidence was obtained to show that the bats moved from the site. The incident was reported to the AAFB security police, who apparently failed to contact DAWR conservation officers.

In May, a resident of Mangilao heard shots in the vicinity of the Marbo cliffline on one night and between the Hawaiian Rock Quarry and Mt. Barrigada on a second night. The man, a former bat hunter himself, believed bats were being hunted rather than deer because he heard repeated shots in quick succession on both occasions.

Public Education

The design and layout of a full color fruit bat poster was started in FY94. Printing of the poster is expected to occur in about November 1994, with 30,000 copies to be made for distribution to schools and the public.

Fruit Bat Imports

A total of 33,220 fruit bats were requested for import during FY94 (Table 3), a decrease of 11.3% from the previous year (DAWR 1993). All requests were made for *P. m. pelewensis* from Palau. The number of bat import permits issued by the DAWR increased to 508 for the year, a small increase of 0.2% from FY93. Approximately 19.0% of all import permits issued by the DAWR in FY94 had fruit bats listed as one of the items requested.

An estimated 8,276 frozen fruit bats in 246 shipments were shipped to Guam from other islands during the year, with virtually all bats reportedly coming from Palau (Table 4). These figures represent a 24.3% decrease in the estimated number of imported bats and a 16.9% decrease in the total number of shipments received, as compared to FY93 (DAWR 1993). The sizes of shipments in FY94 were as follows: ≤ 25 bats, 59.3%; 26-50 bats, 24.4%; 51-75 bats, 7.3%; 76-100 bats, 3.3%; and > 100 bats, 5.7%.

Fewer commercial importers participated in the fruit bat trade this year than in FY93. Only three importers (listed below) brought in more than 300 bats each during the year, as compared to 10 during the previous year. These individuals accounted for 28.6% of the total number of animals imported in FY94, as compared to 47.7% in FY93. This suggests a significant decline in the commercial market for bats on Guam this year. Communication with a fourth person, a Palauan who shipped in 314 bats during the year, indicated that he did so not for commercial purposes, but only as a favor for his friends on Guam. None of his bats were sold for profit.

Table 3. Numbers of frozen fruit bats requested for import to Guam from Palau from October 1, 1993 to September 30, 1994.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total
No. bats requested	3,530	4,556	3,450	2,020	1,730	1,960	1,435	2,430	3,380	3,252	2,295	3,182	33,220
No. permits issued	36	56	58	34	30	28	32	45	46	50	41	52	508

Table 4. Numbers of frozen fruit bats imported to Guam from October 1, 1993 to September 30, 1994.

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Total*	No. of Shipments Received*	No. of Bats Confiscated	No. of Shipments Confiscated
Palau	627	1,170	1,048	284	291	357	350	644	1,447	1,033	526	487	8,264	244	189	11
Yap					3	9							12	2	12	2
TOTAL	627	1,170	1,048	284	294	366	350	644	1,447	1,033	526	487	8,276	246	201	13

*Totals include confiscated bats at Guam ports of entry.

Importer	Shipper	Bats	Shipments
1) Esther Tarkong	Rose Ngirarsaol	1,671	11
2) Fishland	Palau Fish. Coop, F. Reklai	369	3
3) Kodeb (Ray) Yamada	same as importer	325	5
TOTAL		2,365	19

During FY94, 201 fruit bats in 13 shipments were confiscated by the Guam Customs and Quarantine Division and USFWS upon entry into Guam. These figures represented 2.4% of the total number of bats brought to the island and 5.3% of the shipments received during the year. Shipments were seized for a variety of violations including 1) lack of import permits or certificates of origin, 2) the presence of bats killed with shotguns in shipments from Palau, which violated Palau firearms laws and the Lacey Act, and 3) violation of CITES restrictions. Philippine authorities confiscated a shipment of 426 fruit bats with falsified export permits that was destined for Saipan on 21 June (Whaley 1994). The shipment contained 372 *Rousettus amplexicaudatus* and 54 *Eonycteris spelaea* (N. Ingle, pers. comm.).

After the close of FY94, on 1 October 1994, the Republic of Palau signed its Compact of Free Association with the United States. The agreement essentially gives Palau its independence from the U.S. and means that commerce between Palau and the U.S.-governed Pacific island territories will be considered international trade. This will force the termination of exports of *P. mariannus pelewensis* to Guam and the CNMI because of restrictions under the CITES treaty (the bats were placed on Appendix I of CITES in 1989) (Wiles 1994). A similar closure of trade occurred in 1990 when bat shipments were prohibited from entering Guam and the CNMI from the Federated States of Micronesia. Because Palau has been the only legal source of imported fruit bats for residents of both island groups since 1990, this new prohibition will end the bat trade at least temporarily until other sources of animals can be found.

There is much concern among wildlife officials on Guam and in the CNMI that the prohibition on bat imports from Palau will result in the smuggling of bats from Palau and other neighboring islands and that illegal hunting will expand on resident populations of *P. mariannus* in the Marianas (Wiles 1994). Considerable law enforcement effort and public education will be needed to avoid these problems.

RECOMMENDATIONS

1. Survey bat numbers and distribution along Guam's entire northern cliffline once or twice annually. Searches for additional colonies may be productive because continued poaching at bat roosts on Rota can cause large numbers of bats to move to Guam (Wiles and Glass 1990).
2. Continue observations at Guam's bat colonies. Information on reproductive biology, behavior, and social organization will be used to supplement data already gathered.
3. Summarize data previously collected and write reports on the diet, reproduction, and amount of snake predation on fruit bats.
4. Conduct a study of the vegetation, terrain, and proximity to development of known roosting sites to determine what site characteristics are important in the selection of roosting sites by fruit bat colonies.
5. Known bat roosting and foraging areas should be patrolled regularly by DAWR conservation officers. Part of their effort should be aimed at maintaining a visible presence at Jinapsan and Pajon Points, where poaching has been a serious problem in previous years.

6. Form a cooperative bat research program with the CNMI to collect information on the locations and sizes of colonies, reproductive biology and behavior within colonies. Most of the work done under this program would be conducted on Rota where a moderately sized bat population is found but where logistics prevent the CNMI from doing extensive fieldwork. Emphasis of this project would be to identify colonies should they move between Guam and Rota.
7. Continue to monitor fruit bat imports entering Guam.

PROGRAM COST

The estimated cost of the fruit bat project under W-1 R-2 is \$28,000.

LITERATURE CITED

- Division of Aquatic and Wildlife Resources. 1964-1993. Job Progress Reports - Federal Aid to Fish and Wildlife Restoration, Guam. Guam Dept. Agric., Agana, Guam.
- Perez, G.S.A. 1972. Observations on Guam bats. *Micronesica* 8:141-149.
- Stinson, D.W., P.O. Glass, and E.M. Taisacan. 1992. Declines and trade in fruit bats on Saipan, Tinian, Aguijan and Rota. pp. 61-67 in Wilson, D.E. and G.L. Graham (eds.). Pacific island flying foxes: proceedings of an international conservation conference. U.S. Fish Wildl. Serv. Biol. Rep. 90(23). 176 pp.
- Whaley, F. 1994. RP foils frozen fruit bats' illegal journey. *Pacific Daily News*. 1994 July 11.
- Wheeler, M.E. 1979. The Marianas fruit bat: management history, current status and future plans. *Calif.-Nev. Wildl. Trans.* 10:149-165.
- Wheeler, M.E. and C.F. Aguon. 1978. The current status and distribution of the Marianas fruit bat on Guam. *Aquatic Wildl. Resour. Div., Tech. Rep. No. 1*, 29 pp.
- Wiles, G.J. 1987a. The status of fruit bats on Guam. *Pac. Sci.* 41:148-157.
- Wiles, G.J. 1987b. Current research and future management of Marianas fruit bats (Chiroptera, Pteropodidae) on Guam. *Aust. Mammal.* 10:93-95.
- Wiles, G.J. 1994. The Pacific flying fox trade: a new dilemma. *Bats* (in press).
- Wiles, G.J. 1990. Guam Mariana fruit bat and little Mariana fruit bat recovery plan. U.S. Fish Wildl. Serv., Portland, Oregon. 57 pp.
- Wiles, G.J. and P.O. Glass. 1990. Inter-island movements of fruit bats (*Pteropus mariannus*) in the Mariana Islands. *Atoll Res. Bull.* 343:1-6.
- Wiles, G.J., T.O. Lemke, and N.H. Payne. 1989. Population estimates of fruit bats (*Pteropus mariannus*) in the Mariana Islands. *Conserv. Biol.* 3:66-76.

Report prepared by: Gary J. Wiles

**JOB PROGRESS REPORT
RESEARCH PROJECT SEGMENT**

STATE: Territory of Guam

PROJECT NO.: W-1R-2
SUB-PROJECT NO.: W-5
STUDY NO.: 1
JOB NO.: 2

JOB TITLE: Roost Site Characteristics of Marianas Fruit Bats (1440)

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

No significant effort was expended on this job during this segment.

PROGRAM COST

The cost of this job under W-1R-2 was \$ 0.00.

Report Prepared by: Gary J. Wiles

PROGRESS REPORT COORDINATION PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: W-1R-1
SUB-PROJECT NO.: W-6
JOB NO.: 1

PROJECT TITLE: Technical Guidance to Projects Affecting Guam's Wildlife Resources.

JOB TITLE: Technical Guidance to Projects Affecting Guam's Wildlife Resources.
(1210)

PERIOD COVERED: October 1, 1993 to September 30, 1994

BACKGROUND

The professional staff of the Wildlife Section, Division of Aquatic & Wildlife Resources (DAWR) devoted a significant percentage of their time and effort to technical assistance. The pace of development on the island is requiring increasing amounts of time from the Section's staff to fulfill its statutory responsibility to review and comment on development plans, rezoning applications, and various permit applications most of which are local Government of Guam or private sector. In addition the Section also provides comment and review of numerous activities and proposals from the military bases on Guam that may affect Guam's endangered species and wildlife resources and their habitat. Often this would include commenting on U.S. Fish and Wildlife Service (USFWS) Section 7 consultations concerning impacts of military projects on endangered species. Because of the size and complexity of some of these developments, the Section's review responsibility will require a continuing commitment that often extends beyond project completion.

In response to the increase in workload, the Division created the Technical Assistance Program (TAP) within the Administration/Coordination Section. A local appropriation provides funding for two technical assistance staff members, a Biologist I and a Biologist II. These staff are primarily responsible for reviewing projects submitted to the Development Review Committee for action by the Territorial Land Use Commission and for the review of clearing and grading permit applications, but they also participate in the review of other permit applications and environmental documentation. The Wildlife Section's professional staff provide technical support to the TAP staff, and often take the lead in the review of projects involving their particular expertise, such as those that may have endangered species impacts and those involving wetlands. This effort is extremely important for the management and conservation of Guam's natural resources.

OBJECTIVES

1. To minimize adverse environmental impact resulting from the construction of recreational, commercial, residential, industrial, military or public utility facilities.
2. Provide technical assistance to military and civil agencies relative to the management and protection of Guam's wildlife resources.

FINDINGS

The Wildlife Section has been actively involved in the technical guidance function during this segment. Numerous development plans, impact statements, and permit applications have been submitted to the DAWR for review. Field investigations and meetings with responsible agencies have been conducted in many cases as a part of the review process.

Various Section staff members actively serve as members of the following groups:

1. Region IX Regional Response Team - Oceania
2. Fish and Wildlife Conservation Committee - Andersen Air Force Base
3. Pacific Islands Recovery Team for Birds and Bats, USFWS
4. Captive Breeding Working Group, USFWS
5. Area Committee for Oil Spills

Wildlife staff members have attended numerous meetings and hearings pertaining to the protection of Guam's natural resources and have actively consulted with various civil and military agencies on environmental matters. Staff maintains close liaison with the Department of Parks and Recreation, Guam Bureau of Planning, Guam Environmental Protection Agency, University of Guam, U.S. Army Corps of Engineers (ACOE), USFWS, U. S. National Marine Fisheries Service, U.S. Navy, the U.S. Coast Guard, and U.S. Air Force regarding matters of environmental concern. In addition, staff members actively consulted with the numerous off-island visitors, representing various agencies and organizations, who visited during the segment.

The Wildlife Section in cooperation with the USFWS and the University of Guam, sponsored a "Workshop on Censuring Forest Birds and Fruit Bats in Hawaii and the Pacific Islands" at the University of Guam from June 14-16, 1994. Participants attended from American Samoa, the Commonwealth of the Northern Mariana Islands, Guam and Hawaii. Fred Ramsey, Professor of Statistics from Oregon State University, led the technical discussions concerning statistical methods of analyzing survey data.

Considerable public contact was maintained by Section staff during the reporting segment. In addition to occasional interviews on radio, television, and in newspaper, staff members gave talks to a number of civic groups, sportsman clubs, and school and university classes.

More specific Technical Assistance activities of the Wildlife Section included:

1. Participated with Guam Environmental Protection Agency, the Department of Education, USFWS, and ACOE to resolve wetland mitigation issues associated with the construction of the Southern High School in Agat.
2. The Division was represented on the Development Review Committee, which met bi-weekly to review applications for rezoning, variances, and various types of development. The Division's input at this level is important in ensuring that the protection of Guam's fish and wildlife resources is considered in land use planning. Wildlife professional staff provided significant technical input into this review process at various levels on numerous occasions.
3. The Division reviewed and commented on ACOE applications for wetland fill. Mitigation recommendations were often included in these comments. Comments and concerns were also provided to various local agencies. Wildlife staff provided significant input into the responses for these applications. Endangered species were

- of primary concern to the Section with Mariana common moorhens found in many wetlands on Guam.
4. The Section provided technical support to the Division's enforcement staff by identifying and evaluating wildlife, testifying at court hearings, and recommending disposition for confiscated wildlife.
 5. Section staff provided technical assistance to the Department of Agriculture's Plant Protection Quarantine Division by identifying confiscated wildlife and wildlife products, holding wildlife in quarantine, and in general, supporting their efforts at preventing illegal imports of wildlife to Guam.
 6. Section staff reviewed and commented on the proposal to create the Guam National Wildlife Refuge as an overlay on federal and local government land.
 7. The Division reviewed and commented on numerous Environmental Impact Statements and Environmental Assessments of proposed developments, particularly when wildlife issues were present. These comments included recommendations for grading and clearing, erosion control, project design and orientation. These recommendations were made to reduce and/or eliminate impacts to the immediate and adjacent environments.
 8. Section staff provided comments at the request of the USFWS, for numerous Section 7 consultations under the Endangered Species Act, including the following:
 - a. VRC-50 relocation to AAFB.
 - b. HC-5 Squadron relocation to AAFB.
 - c. Several construction projects at U.S. Naval Magazine Guam.
 - d. Numerous military training exercises at AAFB and various Naval bases on Guam.
 - e. Numerous wetland related development activities for both civilian and military projects
 9. The Section reviewed and commented on several legislative bills that would affect wildlife.
 10. The Section responded to many requests for information on laws and regulations pertaining to fish, wildlife, endangered species, hunting and fishing and importation of wildlife.
 11. The Section responded to numerous public requests for information on native wildlife, particularly endangered species.
 12. The Section answered numerous requests for information on hunting from both on and off-island individuals. Specific requests included information on hunting areas, hunter safety classes, firearms regulations, hunting seasons and limits, and laws and regulations.
 13. Section staff provided technical assistance to numerous farmers and the Air Force and Navy regarding pig damage. Damage control permits requests were evaluated and issued when warranted.
 14. Section staff assisted the U.S. Naval Magazine in evaluating and interpreting carabao impacts.

15. Section staff reviewed wildlife-related manuscripts for professional journals. One staff member is an editor for the University of Guam's journal *Micronesica* and in this capacity, reviewed several articles for publication.
16. Section staff assisted in presenting hunter safety briefings at Anderson Air Force Base and the Mangilao Community Center to provide pertinent information to hunters.
17. Section staff made numerous presentations on fish and wildlife resources at meetings of various organizations during the year.
18. Section staff prepared numerous press releases to keep the public informed of fish and wildlife issues including hunting and hunting seasons, brown tree snake issues, fish and wildlife laws and regulations, endangered species, fish and wildlife importation, etc.
19. Technical assistance and logistic support was provided to various USFWS and National Biological Survey personnel working on the brown tree snake problem both on Guam and in the mainland U.S.
20. The Section staff, at the request of numerous developers, met with them, their consultants and other government representatives to discuss proposed development projects and their potential impacts on endangered species, wetlands and native habitat as well as erosion, project design, etc.
21. Section staff provided technical assistance to USFWS and National Marine Fisheries Service law enforcement personnel on various matters including the importation of endangered species items.
22. Technical advice on wetland issues has been provided to the Development Review Section at GEPA.
23. Section staff participated in the Navy Installation Restoration Program by providing information to Navy consultants and accompanying them on several site visits.
24. Section staff continued to spend considerable time assisting in the USFWS's Section 7 review of Navy VRC-50 proposal for flight patterns over endangered Mariana Crow territories at Andersen Air Force Base in northern Guam. In addition, considerable time was spent observing aircraft flying over the impacted areas to monitor compliance with the USFWS Section 7 requirements associated with VRC-50 flight patterns.
25. Section staff participated in an evaluation of HC-5 helicopter flight patterns to be flown at AAFB when the HC-5 Squadron moves to AAFB. Flight patterns were developed that would have minimal impacts on the endangered species found around AAFB.
26. Section staff reviewed potential impacts of U.S. Air Force Thunderbird flying exhibition at AAFB on endangered species found in areas around the base.
27. Staff gave lectures at various University of Guam biology classes on wildlife-related topics.

28. Section staff assisted the military in planning training exercises in the field on various military bases on Guam so that the island's endangered species and their habitat and other wildlife resources would be minimally impacted. Military units involved included the following:
- a. Guam-based Navy Seals.
 - b. Guam National Guard.
 - c. Various Air Force Units.
 - d. U.S. Army units from off-island.
 - e. Air National Guard.
 - f. University of Guam Army ROTC.
 - g. Various DOD special operations units.
 - h. U.S. Army Reserves.
29. On numerous occasions Section staff met with representatives of the press to discuss wildlife issues of interest to the media. Contact was made with the following organizations:
- a. Pacific Daily News, Guam
 - b. KUAM TV News, Guam
 - c. Guam Cable TV News
 - d. KGTF public radio, Guam
 - e. K-57 radio news, Guam
 - f. Los Angeles Times
 - g. New York Times
 - h. Day One, ABC News, New York
 - i. KMGU TV-4, Honolulu
 - j. Hawaii Public Radio
 - k. British Broadcasting Corporation, London

RECOMMENDATIONS

Continue technical assistance activities in support of the conservation of Guam's wildlife.

PROGRAM COST

The estimated cost of the technical assistance project under W-1 R-2 is \$73,000.

Report prepared by: Robert E. Beck, Jr.

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-9

STUDY NO.: 4

JOB NO.: 1

JOB TITLE: Captive Breeding Endangered Native Birds (1480)

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

As of September 30, 1994, there were 99 Guam rails at the Division of Aquatic and Wildlife Resources (DAWR) captive breeding facility on Guam. Nine pairs of rails were successfully introduced for breeding in 1994, and 6 of those pairs produced 17 chicks (3 chicks were hand-reared). One rail escaped and was not found, and 7 adult rails died. Plans were initiated to provide avicultural support to efforts applied toward recovery of the Mariana crow. As of August 1, 1994, there were 52 Guam Micronesian kingfishers in captivity (down from 56 at the start of 1994) at 19 zoos on the U.S. mainland. An initiative was made by DAWR to become more active in the management of the kingfishers, as the status of the kingfishers in captivity has deteriorated.

BACKGROUND

The Guam Native Forest Bird Captive Breeding Program began in 1983 as a cooperative effort between the DAWR, member zoos of the American Association of Zoological Parks and Aquariums (now known as the American Zoo and Aquarium Association, or AZA) and the U.S. Fish and Wildlife Service (USFWS) (DAWR 1983, Derrickson 1986, Shelton 1986). Predation by the brown tree snake, *Boiga irregularis*, now believed to be the single most important factor in the recent drastic decline of Guam's native forest birds (Savidge 1986, 1987; Conry 1988), precipitated the need for a captive breeding program when by 1982, at least five species of Guam endemic species or subspecies were nearing extinction in the wild. Unfortunately by 1984, attempts at captive breeding three of these species, the bridled white-eye, *Zosterops c. conspicillata*, rufous fantail, *Rhipidura rufifrons uraniae*, and the Guam flycatcher, *Miagra freycineti*, were abandoned due to their virtual disappearance from the wild (DAWR 1984).

The Guam rail, *Rallus owstoni*, and Guam subspecies of the Micronesian kingfisher, *Halcyon c. cinnamomina*, were successfully brought into captivity (DAWR 1983-6), with the capture of 19 and 31 wild birds, respectively. Rails first bred at the DAWR's facility on Guam and at the Conservation and Research Center (CRC) of the National Zoological Park in 1984. Dr. Scott Derrickson, Curator of Birds, CRC, National Zoological Park, Smithsonian Institution, Front Royal, Virginia, continued as coordinator for AZA's Guam Rail program. By November 1993, more than 360 Guam rails were produced in captivity.

Reproduction of Mariana crows in the wild continues to be low despite intensive protection against snake predation. Consequently, a plan was devised to initiate avicultural intervention, which will include artificially incubating eggs, fostering chicks back into wild nests, and potentially puppet rearing chicks for release back into the wild. A tour of the

Olinda Endangered Species Propagation Facility and the Peregrine Fund Egg House and Field Aviary in Hawaii was conducted in May 1994 to gather information about the captive management of crows.

Kingfishers were first bred in 1985 at three U.S. zoos (Bronx Zoo, Philadelphia Zoo and the Conservation and Research Center of National Zoological Park). During FY '88, the first studbook for the Micronesian kingfisher was published by the Philadelphia Zoo (Bahner 1989). The kingfisher has been designated as a Species Survival Program species by the AZA. Beth Bahner of the Philadelphia Zoo was designated by the AZA as studbook keeper. The kingfisher program has been relatively successful, as 17 of 29 founders produced descendants (the last previously underrepresented living founder sired offspring in 1994), and the population reached a peak of 62 individuals in August 1990. However, problems such as high chick mortality, high young adult mortality, aggression, and infertility continue to limit population growth. Since 1991, the captive population continued to decline, and the current population number of about 50 birds is equivalent to that of 1988.

OBJECTIVES

Implement and manage captive breeding programs for the Guam rail and other endangered endemic birds by setting up facilities on Guam and at zoos on the mainland U.S. through the AZA. Produce enough Guam rails for release and establishment of an experimental wild population on Rota, CNMI. Enhance reproductive output of Mariana crows in the wild using avicultural support. Become more administratively active in the management of captive Micronesian kingfishers.

PROCEDURES

1. Develop plans for and construct seven steel-framed, 12-stall holding aviaries to replace existing wooden aviaries that have deteriorated from weather and typhoons. Add additional holding aviaries as the need arises.
2. Develop plans and construct a building to support food preparation areas, incubator and brooding equipment usage and storage of supplies and equipment.
3. Continue the routine maintenance and operation of a cooperative captive breeding program for the Guam rail and Micronesian kingfisher with the AZA and its member zoos.
4. Develop techniques for the successful release of captive-reared birds in the wild once the factors responsible for their decline have been controlled.
5. Continue to consult with recognized authorities regarding captive breeding methodology, facility designs, and captive population management techniques.
6. Consult and coordinate with U.S. Fish and Wildlife Service, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits.
7. Breed rails in sufficient numbers to support the continuing introduction of the Guam rail to Rota, which began in 1989.

8. Establish regular contact with the Micronesian kingfisher studbook keeper and make recommendations to the SSP.
9. Coordinate efforts between field and laboratory for manipulating nests, eggs, and chicks of Mariana crows in the wild.

RESULTS

The number of Guam rails at the DAWR's captive breeding facility on Guam increased from 90 to 99 from October 1, 1993 to September 30, 1994. The increase was due to the resumption of the captive breeding program after the hiring of an aviculturist in November, 1993. A total of 22 chicks hatched and 16 survived, while seven adult rails died. One adult rail escaped from its aviary during routine feeding and was never recaptured. Its whereabouts remained unknown and it was presumed dead. Seven adult rails and six rail hatchlings died during the year. One chick died of yolk sac infection (the chick was being hand reared); the cause of death in the other five chicks (being parent reared) was unknown. Of the adult rails that died, two rails were euthanized because of old severe leg injuries, two rails died of age related tumors, one rail was egg-bound, one rail was emaciated (contributing factors unknown), and one rail died of unknown causes. Death by aggression was significantly reduced by using mate choice techniques and by observing rails through a blind during introductions for breeding. Necropsies were conducted by Dr. Ilse Silva-Krott, a veterinary pathologist, at the University of Guam.

A Humidaire incubator and hatcher were purchased in anticipation of avicultural intervention to enhance the reproductive output of the Mariana crows in the wild. The incubators were run and tested on eggs from Guam rails. A total of four rail eggs were incubated and all hatched. The rail eggs were advanced (i.e., had received mostly natural incubation) before they were placed in the machines. Modifications to the wildlife lab were initiated in September 1994 to create an incubator/hatcher room that can be dedicated solely to crow aviculture. Dummy crow eggs were made out of plaster of paris for egg switching purposes.

Micronesian kingfishers continued to be captive bred at 19 U.S. zoos (Bahner 1993). The Guam Micronesian kingfisher population in captivity at the zoos numbered 50 by August 1, 1994. There was good news that a previously underrepresented founder male finally sired offspring in 1994, however, the bird may have been exposed to avian tuberculosis. Further, the captive population has continued to decline since a peak of 62 kingfishers in August 1990. Aggression and infertility are on the rise, there continues to be nutritional concerns, and young adult mortality has increased. An analysis of the 1993 studbook was conducted (see Appendix I) and sent to the studbook keeper for discussion at the 1994 AZA SSP meeting, Atlanta, Georgia. Only four founders survived in 1994.

An aviculturist/wildlife biologist was hired in November 1993 to supervise the captive breeding of Guam rails at DAWR facility and to conduct the release and monitoring of rails on Rota and other locations as selected.

OTHER ACTIVITIES

Dr. Kelly Brock was designated to represent the DAWR on the Captive Propagation Working Group, a subcommittee of the Pacific Avifauna Recovery Coordinating Committee. The first of two meetings per year was held in May 1994, Hilo, Hawaii.

RECOMMENDATIONS

1. Continue the routine maintenance and operation of a cooperative captive breeding program for the Guam rail and Micronesian kingfisher with the AZA and its member zoos.
2. Construct additional 12-stall wooden holding aviaries as needed to support the Rota release of rails. Develop plans for moving rail facility to new site at the Department of Agriculture compound.
3. Develop plans and funding for the construction of a building to support food preparation areas, incubator and brooding equipment usage, and storage of supplies and equipment at new site.
4. Continue to consult with recognized authorities regarding captive breeding methodology, facility design, and captive population management techniques.
5. Assist in the design of appropriate veterinary facilities at the proposed new Department of Agriculture building in order to upgrade support for the DAWR's captive breeding program.
6. Consult and coordinate with U.S. Fish and Wildlife Service, U.S. Department of Agriculture, and other government agencies with jurisdiction over the interstate movement and captive maintenance of wildlife. Acquire all necessary local and federal permits for shipment of rails between Guam and mainland U.S. zoos.
7. Breed rails in sufficient numbers to support the continuing introduction of the Guam rail to Rota.
8. Coordinate with Dr. Scott Derrickson to convert the DAWR's Guam rail records to the system used by member zoos of the AZA. This will facilitate coordination of record keeping between Guam and mainland U.S. zoos.
9. Develop the capability to incubate Mariana crow eggs and rear young in support of DAWR efforts to increase production of crows in the wild through snake-proofing of crow nest sites.

PROJECT COST

The estimated cost of the captive breeding project under E-1-9 is \$89,500.

LITERATURE CITED

- Bahner, E. L. 1989. 1988 North American Regional Studbook for the Micronesian Kingfisher, *Halcyon c. cinnamomina*. Zoological Society of Philadelphia, Philadelphia, Pennsylvania.
- Bahner, E.L. 1993. SSP Master Plan (1993) & 1992 North American Regional Studbook for the Micronesian Kingfisher, *Halcyon c. cinnamomina*. Zoological Society of Philadelphia, Philadelphia, Pennsylvania.
- Conry, P. J. 1988. High nest predation by the brown tree snake on Guam. *Condor* 90:478-482.

Derrickson, S. R. 1986. Captive Propagation of the Guam Rail. The Philadelphia Zoo Review 2:19-23

Division of Aquatic & Wildlife Resources. 1961-1989. Job Progress Reports - Federal Aid to Fish and Wildlife Restoration, Department of Agriculture, Guam.

Savidge, J. A. 1986. The role of disease and predation in the decline of Guam's avifauna. Ph.D. Thesis. University of Illinois, Urbana-Champaign.

Savidge, J. A. 1987. Extinction of an island avifauna by an introduced snake. Ecology 68(3):660-688.

Shelton, L.C. 1986. Captive Propagation of the Micronesian Kingfisher. The Philadelphia Zoo Review 2: 28-31

Report prepared by: M. Kelly Brock and Robert E. Beck, Jr.

APPENDIX I

Analysis of the 1993 North American Regional Studbook of the Micronesian Kingfisher *Halcyon cinnamomina cinnamomina*.

PERIOD COVERED: August 1994

The Micronesian kingfisher conservation program began in 1984 with the transfer of 29 wild caught birds from Guam to the Philadelphia and Bronx zoos for captive breeding. Since 1984, 19 zoos demonstrated enthusiasm and commitment towards the preservation of the Micronesian kingfisher. Participating members have strived to understand the breeding biology and requisites for successful captive breeding of the Micronesian kingfisher, and many advances have been made towards achieving success. Under the careful management and accounting of the population by the species coordinator and studbook keeper, we know that between 1984 and 1989, the captive population slowly expanded and peaked in 1990 to 61 individuals. Since 1990, however, the captive population has started to decline, falling as low as 50 individuals in 1992. The population rebounded to some degree in 1993, however the prospects for 1994 are not looking good. Fertility has declined, behavioral incompatibility and mortality has risen, and there may be nutritional concerns. Further, the sensitivity of the Micronesian kingfishers to exposure to avian tuberculosis continues to be troublesome for the prospective return of kingfishers to Guam.

The Division of Aquatic & Wildlife Resources has identified two major concerns for the future of the captive Micronesian kingfisher population. These concerns (and questions that stem from them) are described below and we request discussion of these concerns at the Species Survival Plan workshop by the participating members of the kingfisher propagation group at the 1994 meeting of the American Zoo and Aquarium Association in Atlanta, Georgia.

I. Although we do not want to discourage enthusiasm and participation of all parks that have taken the kingfishers into their care, the number of institutions involved in the Micronesian kingfisher program now appears to be too many for the small number of birds that currently exist. It appears that as a result, many birds must be moved around often. The following information has been calculated from the studbook for the years 1984-1994, inclusive:

- A. 75% of all adult birds (≥ 1 year of age) are moved from one zoo to another.
- B. The average number of times a bird is transferred is 1.25. While this number may not be high, 45% (51/114) of all adult birds moved were moved more than once.
- C. Average number of transfers a year = 15.6 (1984-1993).
- D. Mortality appears to be high in relation to moving from one zoo to another. 45% (29/65) of all adult mortalities occurred within one year of a transfer. Of those mortalities, 28% died within 1 month (8/29) and 62% (19/29) died within 5 months of a transfer. Based on the average annual number of transfers, it is likely that 7 birds a year will die within one year after a transfer.

For example, in 1993, 11 birds were transferred and 4 died within one year (36%). Three of those mortalities (75%) occurred within 5 months.

*Are reported causes of mortalities of a type that could be induced by stress related to transfers?

*Would consolidation of birds in fewer zoos, (in order to minimize the annual number of transfers) decrease the annual mortality rate?

Recommendation: Consider consolidation of birds in fewer zoos to minimize the number of transfers per year.

II. The apparent increase in behavioral incompatibility between pairs of kingfishers may be related to the fact that 69% (35/51) of living birds were hand-reared (including founders still living). Of captive born birds, 76% were hand-reared. This makes it inevitable that behavioral problems and infertility associated with human imprinted birds will increase as hand-reared birds become older and become the majority of the population.

Of adult birds of prime breeding age, ≥ 3 years (from the 1992 Studbook and 1993 MasterPlan), 70% (23/33) were hand-reared. Only 2 of 11 potential pairings for 1994 are between parent-reared birds.

*Is there a difference in reproductive performance between hand-reared and parent-reared kingfishers?

* Is anyone using techniques such as puppet rearing to avoid imprinting on humans?

*Have any of the hand-reared birds that are potential breeders in 1994 been puppet reared?

* Is cannibalism of chicks greater by adults that were hand-reared vs. parent-reared themselves?

* What other causes of reproductive failures can be attributed to hand-rearing of birds, if any?

* Has anyone tried mate choice instead of forced pairings based solely on genetic recommendations? If so, has it made a difference in reproductive performance?

Recommendation: Try mate choice among a group of birds that are genetically compatible, if it has not already been attempted. Topic needs high priority and scrutiny to determine ways to eliminate problems associated with parent-rearing and minimize hand-rearing.

Report prepared by: M. Kelly Brock

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-9

STUDY NO.: 4

JOB NO.: 2

JOB TITLE: Development of an Experimental Population of Guam Rails in the Commonwealth of the Northern Mariana Islands (1470)

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

No Guam rails from previous releases in 1990 or 1991 were observed on Rota in FY94. No Guam Rails were released in FY94. With the hiring a Guam rail aviculturist in FY94, planning was resumed for releases of Guam rails on Rota for FY95. Relationships were re-established between the new mayor of Rota, Mr. Joseph Inos, the Rota Department of Natural Resources staff, and the Division of Aquatic and Wildlife Resources (DAWR). Field tests were conducted of radio telemetry equipment and receiving stations for triangulation were surveyed and mapped. Preliminary inspections of the release area were made in February, and rat trapping was conducted in June and July 1994. A report on potential predators on future introduced rails was prepared.

BACKGROUND

Since the creation in 1960 of the DAWR, census data from roadside counts, station counts, and transect counts have documented the reduction in range and numbers of the Guam rail, *Rallus owstoni*, and other native birds (DAWR 1961-1987; Jenkins 1983; Engbring and Ramsey 1984). Predation by the brown tree snake, *Boiga irregularis*, is believed to be the major factor contributing to recent declines in native bird populations (Savidge 1986, 1987; Conry 1988).

A captive breeding program for the Guam rail was successfully begun in 1983 on Guam and at U.S. zoos in cooperation with the American Association of Zoological Parks and Aquariums (presently known as the American Zoo and Aquarium Association or AZA (DAWR 1984-1987; Derrickson 1986). Guam rails were first brought into captivity in 1983 on Guam and bred at the DAWR's rail facility in the spring of 1984 (DAWR 1983-4).

The DAWR developed plans to introduce the Guam rail to Rota in order to develop a self-sustaining wild population of rails that will not undergo "domestication" from captive breeding. It is hoped that the experience gained in introducing the rails to Rota will provide valuable information useful for future introductions on Guam. The Rota population may also serve as a partial source of birds for use in reintroducing the rail to Guam when snake predation has been controlled there.

During FY87, a cooperative agreement was signed between the Government of Guam, Commonwealth of the Northern Mariana Islands (CNMI), and the U.S. Fish and Wildlife Service (USFWS) outlining the responsibilities of each entity for the introduction. An environmental assessment was prepared for the USFWS covering the introduction of the

Guam rail to Rota. The DAWR reached an informal agreement with Dr. Stuart Pimm, University of Tennessee, by which a graduate student from the university resided on Rota to monitor the initial two rail introductions in cooperation with the DAWR as a part of his dissertation research. Dr. Pimm was successful in receiving several grants from international conservation organizations to support his efforts in monitoring the introduction on Rota.

After a permit to establish an "experimental population" of Guam rails from the captive population was published by the USFWS in the *Federal Register* (USFWS 1989), a total of 22 Guam rails were released on the Sabana on Rota during three releases in December 1989 and January 1990. All but one rail were released with radio transmitters attached in order to monitor their dispersal, mortality and possible breeding success. Of the 22 released birds, the whereabouts of nine were unknown as their radios failed, four were killed by vehicles, two were killed by cats, two apparently died of starvation, one died of poisoning, and four died of unknown causes (DAWR 1991, Witteman et. al. 1991).

I Chiugai was chosen as the site for the second release of Guam rails on Rota, with 31 rails released there on February 4, 1991 (Witteman and Beck 1991). No long-term success was achieved with either release, and no rails have been sighted or heard since the spring of 1991.

PROCEDURES

1. Continue to captive breed Guam rails needed for the Rota introduction on Guam and at mainland U.S. zoos.
2. Continue to develop techniques and methods for introduction of the rail to Rota.
3. Implement a disease prevention protocol with rails on Guam prior to release on Rota.
4. Continue to introduce Guam rails to Rota.
5. Monitor the release of rails on Rota.
6. Continue to seek funding from conservation organizations to support the monitoring of the introduced rail population.

RESULTS

No rails have been observed on Rota since the last Guam rail release in February 1991 (Stan Taisican, Rota DNR, per. comm.). A playback test was conducted in February 1994 and no rails responded.

The Biologist III Aviculturist/Recovery position, which will supervise the Guam rail releases on Rota, was filled in November 1993 by Dr. M. Kelly Brock. A meeting was conducted in February 1994 with Mayor Joseph Inos of Rota, the Director of Agriculture J. Manibusan, Chief of DAWR R. Lujan, Wildlife Supervisor R. Beck, Dr. Brock, Rota Resident Director of Natural Resources Herman Apatang, CNMI Wildlife Biologists Michael Lusk and David Worthington, Stan Taisican, and several CNMI conservation officers regarding the resumption of the Guam Rail introduction program on Rota. In June and July 1994, preparations for future releases were made by making assessments of potential predators in the release area (see Appendix I).

Preparations also got underway for the monitoring of released rails. In July 1994, the Department of Land Surveys on Rota established coordinates for radio telemetry receiving stations in conjunction with specifications provided by Dr. Brock. A new interior release site was selected, and field tests were made of radio transmitters for range and signal bias. A new prototype transmitter was tested on Guam rails, however the new attachment design was inappropriate for rails. Design modifications to radio transmitters attachments continued through September 1994.

The Division now expects to resume the release of rails on Rota in 1995.

RECOMMENDATIONS

1. Continue to captive breed Guam rails needed for the Rota introduction on Guam and at U.S. zoos.
2. Coordinate with CNMI Division of Fish and Wildlife for the third release and monitoring of rails on Rota.
3. Implement disease prevention protocol with rails on Guam prior to release on Rota.
4. Initiate large third release of rails on Rota at I Chiugai with up to 50 rails from the Division's captive breeding facility and U.S. zoos. Follow-up this release with an additional release within three months and at tri-monthly intervals thereafter, with rails being continuously bred at the Division's captive breeding facility and occasional shipments from zoos. This continuous release pattern should continue until the monitoring on Rota indicates that wild-bred rail production is exceeding mortality in the field.
5. Begin planning for release and first establishment of rails on Guam at Area 50 on Northwest Field, Anderson Air Force Base, as soon as area snake-proofing has been accomplished on the site.

PROJECT COST

The estimated cost of the Rota rail project under E-1-9 is \$17,900.

LITERATURE CITED

- Conry, P. J. 1988. High nest predation by the brown tree snake on Guam. *Condor* 90:478-482.
- Derrickson, S.R. 1986. Captive propagation of the Guam Rail. *The Philadelphia Zoo Review* 2:19-23
- Division of Aquatic and Wildlife Resources. 1961-1991. Job Progress Reports - Federal Aid to Fish and Wildlife Restoration, Guam Dept. of Agriculture.
- Engbring, John and F.L. Ramsey. 1984. Distribution and abundance of the forest birds of Guam: Results of a 1981 survey. U.S. Fish and Wildlife Service, Washington, D.C. FWS/OBS-84/20.
- Jenkins, J.M. 1983. The native forest birds of Guam. *Ornith. Monogr.* 31:1-61.

- Savidge, J. A. 1986. The role of disease and predation in the decline of Guam's avifauna. Ph.D. Thesis. University of Illinois, Urbana-Champaign.
- Savidge, J. A. 1987. Extinction of an island avifauna by an introduced snake. *Ecology* 68(3):660-668.
- USFWS 1989. Establishment of an experimental population proposed for Guam Rail. *Endangered Species Technical Bulletin*, Vol. XIV:4-7
- Witteman, G.J. and R.E. Beck, Jr. 1991. Decline and Conservation of the Guam Rail. pp. 173-178 in Maruyama, N, B. Bobek, Y. Ono, W. Regelin, L. Bartos and P. Ratcliffe (eds.). 1991. *Wildlife Conservation, Present Trends and Perspectives for the 21th Century*, Proceedings of the International Symposium on Wildlife Conservation, The 5th International Congress of Ecology. Yokohama, Japan. 244 pp.
- Witteman, G.J., Robert E. Beck, Jr, Stuart L. Pimm and Scott R. Derrickson, 1990. The decline and restoration of the Guam Rail, *Rallus owstoni*. *Endangered Species Update* 8: 36-39

Report prepared by: M. Kelly Brock and Robert E. Beck, Jr.

APPENDIX I

An Assessment of Potential Predators in the Release Area of the Guam Rail Introduction Program, Rota, CNMI

PERIOD COVERED: September 1994

ABSTRACT

As part of the conservation program for the endangered Guam rail (*Rallus owstoni*), birds produced in captivity will be introduced again to the neighboring island of Rota, Commonwealth of the Mariana Islands, in order to establish an experimental population. A preliminary evaluation of predators in the release and adjacent dispersal areas was conducted in order to assess the feasibility of control programs prior to and during the release of rails. Eight potential predator species were identified and include one species of rat, two species of land crabs, feral cats, monitor lizards, and three species of birds. It is suggested that feral cats and monitor lizards be removed, but further investigation is needed into the feasibility of controlling rats. No control methods are recommended against avian and crab predators. To overcome predation pressures, the habitat should be saturated by regular releases of large cohorts of Guam rails until the rails become established.

INTRODUCTION

The decimation of bird populations on oceanic islands by introduced mammals such as rats, cats, dogs, mongooses, goats, and pigs is well documented (Atkinson 1985). These exotic species can have tragic impacts on introduction programs of indigenous species if predation is not controlled or somehow overcome. For example, the extinction of the Laysan rail (*Porzana palmeri*) was attributed to predation by rats on birds that were translocated to Midway Atoll, as an effort to preserve the species that eventually became extinct on Laysan (Fisher and Baldwin 1946). However, it is possible to minimize predation pressure by one or several methods including predator removal, conditioning release animals to elicit anti-predator behaviors, or by outweighing predation effects by saturating the habitat with members of the introduced species.

The establishment of an experimental population of the endangered Guam rail (*Rallus owstoni*) on a neighboring island in the Northern Marianas was proposed and accepted as a recovery action in 1989. The island of Rota was selected as the preferred site for the introduction of rails for several reasons including its proximity to Guam (60 km north), its ecological likeness to Guam (similar habitats), and the absence of ecological competitors of Guam rails (no modern species of rails or other ground dwelling birds) (USFWS 1989).

Rails were first introduced on Rota in 1989, 1990 (western Rota on the Sabana plateau), and 1991 (eastern Rota at I Chiugai/I Chenchon Park) (see Fig. 1). These were small cohorts of birds released with no long-term success. There were mechanical difficulties with radio transmitters, and staff shortages that rendered follow up difficult or impossible. The fate of most released rails was therefore left unknown (9 of 21 rails released in 1989/1990 and 31 of 33 rails released in 1991). Known causes of mortality included road kills, starvation, stress, predation by feral cats, and possible poisoning. In February 1994, a playback tape survey of the I Chiugai/ I Chenchon Park area yielded no response from Guam rails, suggesting there were no rails in the area. Further, there have been no reports of sightings by local people or staff of the CNMI Division of Fish and Wildlife. It was assumed that all 54 Guam rails released did not survive. Due to the failure of long-

term follow-up, predation on introduced Guam rails was attributed to only two of 12 known mortalities. In two other cases, the cause of mortality was not identified. Both known cases of predation were by feral cats on the Sabana. Consequently, the impact of predation on the previous releases could not be properly assessed.

The objective of the present study was to identify potential predators in the site of future Guam rail introductions on Rota, and surrounding potential dispersal areas, and to evaluate the feasibility of predator control. Further, means to overcome predation pressure, in conjunction with predator removal, are recommended.

MATERIALS AND METHODS

Study Area

The I Chiugai/Sagua'gahga study area is located at the easternmost end of Rota (Fig. 1), and is characterized as a coastal limestone cliff area nearly one square kilometer (about 97 hectares) in size. The gross topography of Sagua'gahga consists of three nested terraces or shelves. The lower and middle shelves contain high quality native forest with the lower area hosting a large seabird colony (Reichel 1991). The uppermost plateau is a mixture of agricultural land, and primary and secondary growth forests. I Chiugai is an area consisting of a mixture of primary forest, scrub (secondary growth), clearings with coconut plantings, and agricultural plots, and is dissected by two secondary roads leading to either agricultural plots on the upper plateau or to I Chenchon Park (an overlook constructed for viewing the seabird colony) on the middle plateau. Nearly all species of native forest birds are found within the boundaries of the study area (see Reichel and Glass, 1991 for a checklist of birds). For a more detailed description of the topography and habitats of Rota, see Wiles *et al.* 1990.

Trapping Efforts

Between June 6-11 and July 17-22, 1994, 56 and 47 (respectively to dates) Victor rat snap traps were set up in five grids or transect lines (all traps 25 meters apart and either attached ~0.5 meter above ground on the base of trees, attached by string to the ground, or left unattached on the ground) in three habitat types: primary forest, secondary (scrub) forest, and a coconut grove. These habitats represent the previous release site for Guam rails in 1991, a newly identified release site for future introductions, and potential dispersal areas (Fig. 2). In Area 1, 25 traps were set in a grid pattern located at the 1991 release site (the western edge of the I Chiugai/Sagua'gahga primary forest at I Chenchon Park). In Area 2, 15 traps were set in a grid pattern in secondary scrub forest adjacent to Area 1 and bounded by the secondary road leading to I Chenchon Park. In Area 3, 16 traps were set in a grid pattern in a small coconut grove with low cut grass, opposite the road bordering Area 2 on one side, and bounded by a seaward cliff on the other side at I Chenchon Park. All grid patterns in I Chiugai followed the natural boundaries of the habitats. In Area 4, 16 traps were set along a transect that traversed down the cliffs from the Rota Fruit Farm on the upper plateau to the middle plateau of Sagua'gahga. The first nine traps dissected secondary scrub growth along an existing trail, while the remaining seven traps dissected primary forest. In Area 5, 25 traps were set in a transect line along a historical road in the Sagua'gahga forest, used by Japanese charcoal makers in the 1920's and 30's. Six additional traps were set off the trail, one towards the outer cliff and 5 towards the inner cliff. The road is now overgrown and inaccessible by motor vehicle, and is visible now as a relatively wide trail that traverses the entire Sagua'gahga forest.

Traps were set between 1630 and 1830, and data were collected between 0630 and 0800 the following mornings. Areas 1, 3, and 5 were trapped for five nights, and Areas 2 and 4

were trapped for four nights. All traps were baited with fresh coconut meat dipped in peanut butter. Untripped traps were closed after data were collected each day, and all leftover baits were discarded to prevent the native avifauna (including one endangered species) from identifying the traps as a potential food source. Data collected included: 1) whether or not a trap was tripped; 2) whether or not there was a capture; 3) the species captured; 4) age class; and 5) sex of the animal when possible to determine.

Rats were the initial target trap animals, however, the high incidence of land crab captures prompted their addition to the study. The number of operational trap nights and the number of animals per species caught per trap night were determined for each area after non-target captures and tripped/no-capture data were eliminated from the data set. Lost traps were also considered non-operational. All other wildlife in the area were noted.

RESULTS

Trapping results are shown in Table 1. A total of 115 rats (all rats were *Rattus rattus*) were trapped: 35 adult males, 51 adult females, 13 juvenile males, 12 juvenile females, and 4 of unknown sex (carcasses were scavenged during the night). The area with the least number of rodents trapped was the Old Japanese Road, the area identified as the release site for future Guam rail introductions. Rats were often seen during the daytime, either crossing the road between agricultural plots close to I Chenchon Park, or crossing the road leading into I Chenchon park between trap areas 2 and 3. Crabs made up 51% (121 of 236) of all captures. Most coconut crabs (*Birgus latro*) were caught in primary forests, while most hermit crabs (*Coenobita brevipennis*) were caught in secondary forests. Monitor lizards (*Varanus indicus*) were sighted in each of the habitats (one lizard was seen carrying a rat carcass) and a feral cat (*Felis silvestris*) was seen at I Chenchon Park. Most species of native forest birds were seen in I Chiugai and Sagua'gahga forests and on the Rota Fruit Farm. At least two or three Mariana crows (*Corvus kubaryi*) and numerous collared kingfishers (*Halcyon chloris*) and Micronesian starlings (*Aplonis opaca*) were seen or heard every day in each trap area.

Table 1. Trap success of *Rattus rattus*, *Birgus latro*, and *Coenobita brevipennis* in five habitats designated as release and dispersal areas for the Guam Rail Introduction Program, Rota, CNMI. Numbers are animals caught per trap night and numbers in parentheses are operational trap nights. I Chiugai (primary forest & coconut grove sites) and the Old Japanese Road in Sagua'gahga (primary forest) were trapped for five nights and I Chiugai secondary forest and the Sagua'gahga Fruit Farm trail (secondary and primary forests) were trapped for four nights. The number of animals per trap night in Area 2 was confounded by the fact that all traps were tripped and the only operational traps were those that captured animals.

Trap Area	Site	Habitat	<i>R. rattus</i>	<i>B. latro</i>	<i>C. brevipennis</i>
1 ^{a,c}	I Chiugai	primary forest	0.45 (60)	0.43 (58)	0.06 (35)
2 ^c	I Chiugai	2ndary forest	1.00 (28)	1.00 (1)	1.00 (9)
3 ^c	I Chiugai	coconut grove	0.43 (67)	0 (0)	0.10 (42)
4 ^c	Sagua'gahga	Fruit Farm	0.67 (15)	0.38 (8)	0.85 (33)
5 ^{b,c}	Sagua'gahga	Old Japan. Rd.	0.37 (57)	0.31 (52)	0.50 (72)

^a 1991 Release area; ^b Proposed site for future introductions; ^c Potential dispersal areas.

DISCUSSION

The extirpation or extinction of many species of island birds is considered to be the result of the introduction of rats and other small mammals by Europeans in the 18th, 19th and 20th centuries (Moors *et al.* 1992; Atkinson 1985). Although perching birds make up the largest percentage of species decimated by rats, rails are clearly one of the most vulnerable groups of birds. Rail species thought to have suffered or gone extinct partially due to the introduction of rats include the: Banded rail *Rallus philippensis dieffenbachii* (New Zealand), Laysan rail *Porzana palmeri*; Tahitian rail *Rallus pacificus*, Iwo Jima rail *Porzana cinerea brevipes*, Kusaie Island rail *Porzana monasa*, Wood rail *Gallinula pacifica* (Samoa), Barred-winged rail *Rallus poeciloptyx* (Fiji), and Ascension Island rail *Atlantisia elpenor* (Atkinson 1985; Ripley 1977). There are however, many islands whose avifauna were not affected by the introduction of rats. This is especially true of tropical and subtropical islands between the latitudes 15°N and 20°S (Atkinson 1985). It was suggested that birds on these islands evolved defensive behaviors against predators because of the presence of land crabs. Although land crabs are usually scavengers and grazers, there were many observations of bird eggs and chicks eaten by land crabs when the opportunity arose (see Atkinson 1985 for discussion).

Rail species that currently coexist with rats include the white-throated rails *Canirallus cuvieri* (Aldabra) and the endangered Lord Howe Island Woodhen (*Tricholimnas sylvestris*). Predation by *R. rattus* on the Lord Howe Island Woodhen seems minuscule as the densest rat population on the island is sympatric with the densest population of woodhens. (Miller and Mullette, 1985). This is unusual given that *R. rattus* appears to have been responsible for the extinction of five species of land birds on Lord Howe Island (Atkinson 1985) since their introduction in the early 1900s. In the area with the densest population of *R. rattus* on Lord Howe Island, trapping success was 0.45 rats per trap night, similar to the results on Rota.

There has been no documentation of Guam's avifauna (nor that of the other Mariana Islands) suffering from the establishment of rats. The Guam rail coexisted with rats prior to the establishment of the brown tree snake. Lint (1968) estimated that there were 21,000 rails on Guam prior to WWII and 80,000 rails in 1968, living primarily in forested areas but also found in secondary growth, and grasslands (Ripley 1977). In a study of rodents on Guam in 1945, Baker (1946) found that *R. rattus* was the most widespread rodent on the island. The rats were found in all habitat types (including around human habitation), and more than half of the rats were caught in grasslands, forests, and coconut groves. Baker determined that rats lived in densities ranging from 10.4 - 28.7 rats per hectare, depending on the time of year. Rat densities appeared highest in May and June, dropped throughout July and August, and rebounded again in October. Baker attributed this fluctuation in population densities to wet conditions that prevailed during July and August. *R. exulans* was also trapped during Baker's study, but these rats had a much more restricted range than *R. rattus* and were far less numerous.

Of the characteristics that make birds more or less vulnerable to decimation by rats, Guam rails rank less vulnerable in 6 of 8 categories of life history traits (from Atkinson 1985) (Table 2). The reproductive strategy of the Guam rail demonstrates that it is capable of rapid expansion. The Guam rail matures at an early age, probably has a short generation time, produces multiple broods per year (often sequential clutches of eggs are started within 7 to 14 days of the previous hatches), and chicks are semi-precocial usually feeding on

* Antedoctal evidence in the captive breeding program at the DAWR suggests a high cost in mortality to the seeming selected breeding strategy of the Guam rail.

their own by 2 weeks of age. Further, Guam rails are extremely secretive by nature, especially when nesting.

Table 2. Life history traits of the Guam rail (in *italics*) relative to its vulnerability to decimation by rats. Timing of breeding refers to the year-round breeding of rails, and parent attentiveness refers to not having to leave chicks to forage for food. Nest location was not considered as all bird nests are vulnerable to *R. rattus* (traits from Atkinson 1985.).

Trait	Degree of Vulnerability	
	More	Less
Size	<i>Small</i>	Large
Aggressiveness	Not very	<i>Very</i>
Roost	<i>Close or on ground</i>	High off ground
Timing of breeding	Coincides with rats	<i>Does not coincide</i>
Reproductive Strategy	Long, slow	<i>Short, fast</i>
Parent attentiveness	Intermittent	<i>Constant</i>
Ability to renest	No	<i>Yes</i>
Lives with other predators	No	<i>Yes</i>

The potential effects of other predators in the I Chiugai and Sagua'gahga areas on rails are difficult to assess. Land crabs feed on bird eggs and chicks (especially seabirds) on other tropical islands (see Atkinson 1985 for review), and the results of this study suggest that coconut crabs and hermit crabs are just as abundant as rats. Monitor lizards are common on Rota, especially in forest and secondary growth. The number of feral cats on Rota has not been estimated but the impact of feral cats on other island avifauna is also relatively well documented (Atkinson 1985).

Crows, kingfishers, and starlings are also potential predators of Guam rail eggs and chicks. Bird eggs had been reported as a component of the diet of the Mariana crow (*Corvus kubaryi*) (Beatty 1946). Both the Micronesian kingfisher (*Halcyon cinnamomina*) and collared kingfishers (*H. chloris*) had the reputation for chasing and harassing poultry chicks and bridled white-eyes (*Zosterops conspicillatus*) (Marshall 1949; Beatty 1946) but there were no documented captures. Further, Micronesian starlings (*Aplonis opaca*) were observed eating the eggs of seabirds and it has been suggested that egg predation by starlings could be a significant factor limiting nest success of black noddies on the Mariana Island of Guguan (Reichel and Glass 1990). All three potential avian predators of Guam rails thrive in the I Chiugai and Sagua'gahga areas in relatively high densities (starlings and kingfishers) and low to moderate densities (crows).

Guam rails lived sympatrically for hundreds of years on Guam with crows, kingfishers, starlings, land crabs, monitor lizards, and rats. The Guam rail must have evolved some anti-predator behaviors in order to withstand predation pressure, especially after the invasion of rats, to maintain its existence as a ground dwelling, flightless bird. Only after the balance of nature was tipped by the introduction of the brown tree snake (*Boiga irregularis*) to Guam did the Guam rail flounder and crash. The important question is whether or not rails can establish themselves on Rota in the face of already established predators, and whether or not the introduction of rails will cause a significant shift in predation habits. For example, studies of monitor lizards (Dryden 1965; McCoid and Witteman 1993) indicated that rats, land crabs, and arthropods comprised the bulk of the

diet of monitor lizards. Although monitor lizards have been labelled as agricultural pests on Rota because of their apparent ventures into farms and their predation on chicken eggs and chicks (Wiles *et al.* 1990), birds and bird eggs (specifically *R. owstoni*) comprised only a very small portion of the monitor lizard's diet; (< 2% [2 of 110] of monitor lizard stomachs examined contained birds or bird eggs).

It is nearly impossible to weigh the potential impact of one predator against another on introduced rails, and clearly a control program for each avian and crab predator is impossible and unthinkable. Feral cats can be trapped and removed from the release area, and the inadvertent capture and removal of monitor lizards in cat traps is possible. Short-term control of rats is more difficult because of the inevitable reinvasion of rats from surrounding areas, the chances of nontarget secondary poisoning, the necessity that treatments must be repeated to be effective, and that the costs may outweigh the benefits (Moors *et al.* 1992). Since it is unknown how long it will take before Guam rails get established on Rota, the risk to nontarget species and the manpower required to maintain rat control may render rat control inadvisable. Further, it is unknown what effect rat control could have on the balance of established predator-prey relationships. For example, will rat control cause a shift in monitor lizard predation from rats to birds, including rails?

Recommendations

1. Trap and remove feral cats from I Chiugai and Sagua'gahga forests, and immediate surrounding areas.
2. Continue to investigate the feasibility of a short-term rat control program. (Currently there are no rodenticides registered for field use. A special local need permit [SLN(24)] may be required.) Do not concentrate on removing monitor lizards (except for the inadvertent catch), as they may control the rat population if rat control by poisoning is not employed.
3. Release large cohorts of Guam rails on a continual basis to saturate the area until the species becomes established.
4. Monitor mortality factors in introduced Guam rails as closely as possible, especially incidence of predation.

LITERATURE CITED

- Atkinson, I.A.E. 1985. The spread of commensal species of *Rattus* to oceanic islands and their effects on island avifauna. In Moors, P.J. (ed.) Conservation of island birds. *ICBP Technical Publication* No.3:35-81.
- Baker, R.H. 1946. A study of rodent populations on Guam, Mariana Islands. *Ecol. Monogr.* 16:393-408.
- Beaty, J.J. 1967. Guam's remarkable birds. *S.Pac. Bull.*(4): 37-40.
- Dryden, G.L. 1965. The food and eating habits of *Varanus indicus* on Guam. *Micronesica* 2:73-76.
- Fisher, H.I. and P.H. Baldwin. 1946. War and the birds on Midway Atoll. *Condor* 48: 3-15.
- Lint, K.C. 1968. A rail of Guam. *Zoo Nooz.* (Zool. Soc. San Diego) 41: 16-17.

- Marshall, J.T., Jr. 1949. The endemic avifauna of Saipan, Tinian, Guam, and Palau. *Condor* 51:200-221.
- McCoid, M.J. and G.J. Witteman. 1993. *Varanus indicus* (Mangrove Monitor). Diet. *Herpetol. Rev.* 24:105.
- Miller, B. and K.J. Mullette. 1985. Rehabilitation of an endangered Australian bird: the Lord Howe Island Woodhen *Tricholimnas sylvestris* (Sclater). *Biol. Conserv.* 34: 55-95.
- Moors, P.J., I.A.E. Atkinson, and G.H. Sherley. 1992. Reducing the rat threat to island birds. *Bird Conserv. Internatl.* 2:93-114.
- Reichel, J.D. 1991. Status and conservation of seabirds in the Mariana Islands. *ICBP Technical Publication* No.11: 249-262.
- Reichel, J.D and P.O. Glass. 1990. Micronesian starling predation on seabird eggs. *Emu* 90:135-136.
- Reichel, J.D. and P.O. Glass. 1991. Checklist of the birds of the Mariana Islands. *Elepaio* 51:3-10.
- Ripley, S.D. 1977. Rails of the world. D.R. Godine, Boston.
- U.S. Fish and Wildlife Service. 1989. Endangered and threatened wildlife and plants; determination of experimental population status for an introduced population of Guam rails on Rota in the Commonwealth of the Northern Mariana Islands. *Federal Register* 54(208):43966-43970.
- Wiles, G.J., G.H. Rodda, T.H. Fritts, and E. M. Taisacan. 1990. Abundance and habitat use of reptiles on Rota, Mariana Islands. *Micronesica* 23:153-166.

Report prepared by: M. Kelly Brock

JOB PROGRESS REPORT RESEARCH PROJECT SEGMENT

STATE: Territory of Guam

PROJECT NO.: E-1-9

STUDY NO.: 7

JOB NO.: 3

JOB TITLE: Development and Testing of Control Methods for the Brown Tree Snake (1470)

PERIOD COVERED: October 1, 1993 to September 30, 1994

SUMMARY

Field tests of electrical barriers designed to prevent predation of Mariana crow nests by brown tree snakes continued this fiscal year. Twenty-eight active nests were snake-proofed. Snake-proofing of active nests during the nest building phase has netted both three and two-egg clutches, as well as one-egg clutches. Of three nestlings produced, two fledged successfully. Results of a study of the efficacy of electrical barriers indicated that snakes were not able to pass over electrical barriers installed on typical crow nest trees.

BACKGROUND

Roadside counts by the Guam Division of Aquatic and Wildlife Resources (DAWR) have documented the decline of native forest birds on Guam (DAWR 1974-1988). Studies by Conry (1988) and Savidge (1986, 1987) have indicated that predation by brown tree snakes, *Boiga irregularis*, is the main cause of this decline.

Attempts have been made to develop adequate and effective means of protecting active nests of the Mariana crow, *Corvus kubaryi*, from predation by snakes. Clearing of vegetation in direct contact with the nest tree, snake trapping, use of galvanized sheet metal girdles, and use of Tangle-Foot, an adhesive resin, have all been tried. The use of sheet metal girdles and Tangle-foot was partially successful, but resulted in the mortality of nest trees and was therefore discontinued. Clearing of vegetation and snake trapping has met with some success.

Recently, active nest trees have been protected successfully with the use of electrical barriers placed on the trees' trunks combined with clearing of adjacent vegetation (Aguon et al., 1992). Successful protection of active nests in FY '92 resulted in the fledging of three crows from two nests (DAWR 1992). These were the first fledglings in the wild since late 1985.

OBJECTIVES

To develop methods in controlling brown tree snake predation on active nests of native birds.

PROCEDURES

1. Field testing and implementation of electrical barriers.

2. Field test the timing of placement of electrical barriers in addition to snake trapping.

RESULTS

Field use of electrical barriers to protect Mariana crow nests from brown tree snake and monitor lizard (*Varanus indicus*) predation continued this fiscal year. Night-time electrification of nest trees continues to be important in protecting nests prior to egg laying.

During the crow breeding season from September 1993 to May 1994, intensive searches were carried out in northern Guam to locate crow territories and nest sites. Barriers were placed on nest trees during the night as soon as nest building was first observed. Both solar powered and battery powered electrical barriers were used. Maintenance of the barriers was carried on throughout the nesting season. Most barriers were removed at the end of the breeding season. Trapping for snakes and monitor lizards occurred in and around the nest trees. Care and feeding of mice used as bait in traps occurred on a regular basis. In addition, considerable time at night was spent visually searching the nest trees and surrounding areas for snakes and monitor lizards.

Twenty-eight Mariana crow nests built by 10 pairs of crows were snake-proofed this breeding season. At least seven of the nests were later observed to have birds incubating. Six of these 7 nests were protected early during the nest building phase. The seven nests belonged four breeding pairs of crows. At one nest, birds were already incubating when the tree was snake-proofed during the daytime.

Attentive periods of 20-30 minutes were used as an indirect method of determining that a nest was complete and that birds were incubating eggs. After the first week of incubation, these nests were mirrored to determine clutch size. This year's snake-proofing of active nests during the nest building phase resulted in an increase in clutch sizes compared to records prior to 1993. Clutch sizes of protected nests were as follows: three eggs at four nests, two eggs at two nests, and one egg at one nest. This marks the second season that clutch sizes of three have been noted after the installation of electrical barriers.

Snake-proofing early in the nest building phase allows for the removal of snakes already present in nest trees prior to placement of a barrier. Snakes were present at 13 of 27 (48%) nests that were snake-proofed at night during the nest building phase. Thirty-six snakes were found around nest trees, even in the absence of any eggs or birds. A total of 343 snakes were caught during from November 10, 1993 to May 17, 1994. Of these snakes, 232 were females (mean snout-to-vent-length (SVL) = 971.4 mm, SD = 10.46, n = 232; mean total length (TTL) = 1214.4 mm, SD = 16.80, n = 229; mean weight = 99.44 g, SD = 45.95, n = 230) and 106 were males (mean SVL = 1029.4 mm, SD = 12.45, n = 106; mean TTL = 1285.0 mm, SD = 19.49, n = 105; mean weight = 199.64 g, SD = 70.92, n = 105).

The number of snakes that were caught in traps at successful and abandoned nests differed slightly. Successful nests (n = 7) had an average of 0.34 snakes per trap night (SD = 0.25, 95% Confidence Interval = -0.15-0.83). Abandoned nests had 0.39 snakes caught per trap night (n = 20, SD = 0.18, 95% Confidence Interval = 0.03-0.75). This difference was not significant (t-test, p = 0.566, df = 20). Unsuccessful nests were recorded in the CWSA, Tarague and WSA areas, while successful nests were found at Northwest Field and Late Point. Abandonment of these nests was not due to predation of eggs. Further investigation is needed to determine if encounters with snakes by breeding birds in these areas are causing abandonment.

While snake-proofing is important in improving the nesting success of crows, other factors also appear to be negatively affecting their reproductive success. Of seven clutches produced, 4 clutches holding a total of 12 eggs failed to hatch, one clutch of 2 eggs was possibly dumped by intruder birds, and two clutches of three eggs successfully hatched. Eight eggs from four clutches that failed to hatch were collected; of these, 6 eggs had no sign of development and were possibly infertile, and 2 were fertile. One fertile egg had a late dead embryo. Two birds successfully fledged from the three eggs that hatched. The third nestling died of a possible yolk infection. It appears that crows are having problems with incubation as the hatch rate (20%) is lower than the fledging rate (60%).

From June 13-July 25, 1994, in cooperation with Earl Campbell of the National Biological Survey and John Morton of the USFWS, controlled tests of electrical barriers were conducted in Northwest Field, CWSA, Tarague, and WSA. Twenty former crow nest trees used in the 1993-94 breeding season were selected for the experiment. Vegetation around these nest trees had been previously cleared, therefore, little effort was involved in the preparation of these trees for testing. From this group, ten trees were randomly selected for the control group and had their electrical barriers turned off, while the other 10 trees of the experimental group had their electrical barriers turned on. During the second phase of the test, the conditions were reversed. Where more than one tree had been electrified to protect a nest site, the setup was considered as one tree.

Two snake traps were suspended above the electrical barriers in each tree using 1/8 inch nylon rope. Snake traps were checked daily during daylight hours. Snake traps were modified crayfish traps similar to those used by Rodda et al. (1992). Traps were baited with white laboratory mice, *Mus* sp., which were housed in a wire mesh rectangular container placed in the trap. Mice were fed a mixture of cracked corn and pellets, with a slice of potato added for moisture. Cylindrical tubes of foil (3 cm diameter) were placed in traps and used to detect escapes of snakes that had entered traps (Rodda et al. 1992). These cylinders of foil were reshaped or replaced as needed. The following measurements were taken of each snake; snout-to-vent length, total length, sex, weight, and reproductive condition. The number of ovarian follicles or yolked follicles was recorded for females. Stomach contents were noted.

Before the experiment began, all electrical barriers were turned on for seven days and trees were trapped to remove any snakes present. During phase I, electrical barriers in control trees were turned off. Daily trapping continued in all trees for 14 days. After the last day, all electrical barriers were again turned on for 7 days to remove any snakes in trees. This was followed by reversing the conditions for each tree, i.e. trees which were selected as controls in phase I were experimental trees in phase II, and vice versa. Trapping continued during the second phase. All captured snakes were removed, and the number of snakes caught each day and the number of crushed foils pieces were recorded.

Unfortunately, some data had to be excluded from analysis because of questionable reliability. This left 6 sample days from each phase (a total of 12 sample days compared to the 28 originally intended prior to the start of the experiment). Results based on the remaining sample indicated that electrical barriers were successful in preventing the passage of snakes to nesting sites. No snakes were caught in trees where electrical barriers were turned on (even the excluded data recorded no snakes in electrified trees). However, 19 snakes were caught in trees with barriers turned off. The mean number of snakes caught in control trees was 2.0 snakes per tree (SD = 2.10, n = 20). The effectiveness of electrical barriers in protecting active crow nests is further supported by this study. These results suggest that electrical barriers placed on the trunks of crow nest trees are highly effective in preventing snake access to nests. The experiment will be repeated in the next fiscal year.

RECOMMENDATIONS

1. Continue laboratory tests of possible means of protecting active native bird nests.
2. Conduct on site tests of methods, which prove effective in laboratory experiments on active nest trees.

PROGRAM COSTS

The estimated cost of the brown tree snake project under E-1-9 was \$71,600.

LITERATURE CITED

- Aguon, C. F., R. E. Beck, Jr., and M. W. Ritter. 1992. A method for protecting nests of the Mariana Crow from Brown tree snake predation. Proceedings of the US-Japan Joint Congress on Snake Control for Human Health and Wildlife Conservation. The Snake 24:106.
- Conry, P. J. 1988. High nest predation by the brown tree snake on Guam. Condor 90:478-482.
- Division of Aquatic and Wildlife Resources (DAWR). 1974-1989. Job Progress Reports - Federal Aid to Fish and Wildlife Restoration. Guam Dept. of Agriculture.
- Rodda, G. H., R. J. Rondeau, T. H. Fritts, and O. E. Maughan. 1992. Trapping the arboreal snake *Boiga irregularis*. Amphibia-Reptilia 13:47-56.
- Michael, G. 1987. Notes on the breeding biology and ecology of the Mariana or Guam Crow. Avicult. Mag. 93:73-82.
- Savidge, J. A. 1986. The role of disease and predation in the decline of Guam's avifauna. Ph.D. Thesis. University of Illinois, Urbana-Champaign.
- Savidge, J. A. 1987. Extinction of an island avifauna by an introduced snake. Ecology 68(3):660-668.

Report prepared by: Celestino F. Aguon

